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March-April 1956

Volume VII

Number 2

Official Publication of the

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS, INC.

NATIONAL OFFICERS, 1955–1956

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THE JOURNAL OF

Industrial Engineering

OFFICIAL PUBLICATION OF
THE AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS, INC.

Published Bi-monthly

AIIE Headquarters and Publication Offices, 145 North High Street, Columbus 15, Ohio

Editorial Office—A. French Building, 225 North Avenue, N.W., Atlanta 10, Georgia

Second-class mailing privileges authorized at Columbus, Ohio

VOL. VII *March-April, 1956* **NO. 2**

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SUBSCRIPTION PRICES: $6, one year; $10, two years; single issues, $1.50.

ALL MANUSCRIPTS for review should be submitted with drawings suitable for reproduction to the Editor-in-Chief, Journal of Industrial Engineering, A. French Building, 225 North Avenue, N.W., Atlanta 10, Georgia.

ADVERTISING RATES available from the Advertising Manager or any Editorial Board member. Send copy and cuts to the Advertising Manager, A. French Building, 225 North Avenue, N.W., Atlanta 10, Georgia. Final due dates for copy: Nov.–Dec. issue, Sept. 15; Jan.–Feb. issue, Nov. 15; Mar.–Apr. issue, Jan. 15; May-June issue, Mar. 15.

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PRESIDENT'S MESSAGE

The Shortage of Engineering Talent

By E. L. Slagle

President, American Institute of Industrial Engineers

It is almost impossible to pick up a newspaper or a magazine these days without reading something with regard to the shortage of engineering and scientific talent. As engineers and citizens, we have responsibilities in this matter which cannot be overlooked. As a nation, we are headed for serious trouble if we permit ourselves to become second rate in the matter of technological advance.

That there is an awareness of the need to develop and properly utilize our technological manpower is indicated by the attention to the situation being given by the Government, industry, our universities, and many national professional organizations. As an indication of governmental interest in Washington recently, there was formed the "President's Committee on Training of Engineers and Scientists". The Engineer's Joint Council, the Engineer's Council for Professional Development, the National Society of Professional Engineers, and the many founder societies have active committees assigned to one or more facets of the problem. There is evidence that much progress has been made. Due to the seriousness of the situation and to the fact that we are merely beginning to grapple with it, there is still much to be done. We cannot sit back and content ourselves with the thought that others are working on the problem.

The American Institute of Industrial Engineers can, and will, work with other organizations in their efforts to establish objectives and coordinate the activities of the various representatives of industry, professional societies, universities, and the Government. There are actions which we, as individuals, can take. In this message I want to review with you some aspects of the problem and suggest some courses of action open to us.

It would appear that the trouble stems from two sources: (1) the accelerated rate of technological advance, and (2) our democratic ideal of mass education. Technological advance creates a shortage, whereas the principle of mass education seems to affect quality.

Considering the matter of a shortage of engineering and scientific talent, we find that this can be attributed to any one of a number of things such as: (1) the failure to interest a sufficient number of secondary school students in these fields; (2) the improper utilization of engineers in positions requiring something less than the engineering approach; and (3) the high percentage of engineers currently used in management positions.

The quality problem, too, has become acute. It is not difficult to single out the source of the trouble. Approximately forty million individuals are now attending U. S. schools. Approximately fifty million will be attending by the end of the next decade. Only 1.5 per cent of our income goes to the schools. Despite the fact that there is a real shortage of teachers and classrooms, school bond issues consistently run into trouble. It is interesting to note that practically everyone believes in equal rights—and equal educational opportunities—but that we can eke out only such a small percentage of the taxpayer's income to support the schools. It is no wonder that civic leaders are forced to consider federal aid in an effort to avoid an edu-

cational disaster. Actually, depriving the school system of money represents a saving to no one. This money situation contributes to the low salary scale of our teachers. Although there are certain communities in which teachers' salaries are adequate, it is nevertheless true that, on the average, and even in the majority of our communities, teachers' salaries are woefully inadequate. It follows that inadequate salaries attract inadequate teachers. In general, an individual has to be dedicated to the task of teaching or be an individual of very high principle to remain on a job which pays so little.

Our system of mass education leads to other unfortunate results. Since we have reached the point of an "education for everyone" before we were actually set up to handle a job of such magnitude, we actually have, in many cases, a "mediocre education for everyone" rather than an "education for everyone". In addition to this, we see a sort of leveling out process developing. Children, particularly teenagers, work very hard at being one of the gang. Their desire to conform is aided by such agencies as radio, television, and motion pictures. It is a source of concern to me that our schools foster, rather than combat, this leveling out process. This country thrives on individual thinking and individual ambitions, and progresses due to constructive changes which have their origin in differences.

Another negative factor in this regard stems from the scatter gun approach to the establishment of curricula in our secondary schools. Our high schools are bogged down in their attempt to be everything to everybody. When it comes to courses taught—you name it, they have it. In general, there are three types of courses: vocational, college preparatory, and general. These three courses of instruction, cluttered up as they are with odd subject matter added as a result of community pressures, do not prepare students for engineering careers. Insufficient time, or no time, is devoted to some subject matters such as algebra, geometry, trigonometry, physics, or chemistry. Approximately one-fourth of our high schools do not offer geometry, physics, or chemistry. Enrollment in such courses is steadily declining. Many engineering students simply cannot pass the necessary examinations for entrance into the universities; or, if they are admitted into the universities, they must take make-up courses which will prepare them for the initial college-level work. In short, the universities have difficulty producing due to lack of raw material and to lack of qualified raw material—it is a quantity and quality problem, even at this point in the educational process.

The universities' problems are further aggravated by the necessity to cope with the ever-expanding sphere of engineering and science and with the problem of developing individuals who are both technically capable and professionally oriented. It is no longer possible to turn out engineers or scientists with the thought that they will remain strictly technicians. The rapid technological rate of change previously referred to has created a great demand for engineers who cannot only analyze and design, but who can also operate and administer. This has focused attention upon the development of proper educational programs with emphasis on the social sciences and humanities fields. Much work is being done with regard to rearranging and revising engineering curricula (a recent report by the American Society for Engineering Education with regard to this matter is well worth reading). In addition it should be noted that the salary problem exists in our universities as well as in our high schools.

What we can do about many of these problems is fairly well indicated by this review. To name just a few possible actions which we can take:

1. We can join with community groups attempting to solve local school problems—whether the group is a service club or the PTA; or whether the problem is one of school bonds, or one of should our children learn to read by the use of the phonetic or by the use of sight-recognition type of instruction.

2. We can participate in guidance work at the high schools. The practicing engineer can be of material assistance in the high school guidance programs. If more of our secondary school students had a comprehensive picture of engineering, it is reasonable to assume that more of these students would be attracted to the field. This is not to say that every individual so attracted will be properly qualified.

3. Local chapters of the AIIE should take an active interest in student chapters. If there is a student chapter nearby, there should be a determined and organized effort to assist this group. If there is not a student chapter in your nearby university, you should be interested in starting one.

4. You can help your chapter of the AIIE if, and when, it sponsors an institute or conference, or when it agrees to help a local university sponsor a similar meeting.

5. When you are discussing the shortage of engineers or the shortcomings of our school system with your friends, whether this is over a cup of coffee, in your home, or while riding to and from work, do what you can to create an understanding of the problem. Remember that they have influence both as taxpayers, and with their friends. It shouldn't be too hard to convince them since your position—the degree of success in improving the quantity and quality of engineers and scientists produced in this country will vary directly with the amount of time, effort, and money applied (or to say it another way, you get what you pay for)—is rather unassailable.

Registration of Industrial Engineers

By S. E. Scharff, P.E.

Chairman, National Committee on Professional Registration, AIIE

Any article concerning the registration of engineers which does not start with a statement of the primary purpose of such registration might be subject to justified criticism. Therefore, let us state immediately that the primary purpose of the registration of engineers is to protect "the public" from the abuses of unqualified persons rendering inferior services. "The public" is usually considered as including the citizenry in general, their public servants, governmental institutions and agencies, and the various individuals, partnerships, and corporations which constitute the economic fabric of any community.

Therefore, if you had any idea that registration laws were passed for the benefit of engineers, you had best modify your thinking a bit. However, not too much modification will be necessary because registration laws benefit the engineer greatly even though not passed for that purpose.

Any human agency, group or endeavor will inevitably produce a few members whose actions are detrimental to the body as a whole. Without some sort of control it is usually impossible for the group to curb or regulate such undesirable actions, so that the group must continue to suffer silently. (Those of us who were practicing industrial engineering in the heyday of the "efficiency expert" probably have a keener realization of this fact than the younger members of the profession. However, all of us still feel the sting of that term when applied to us.) Registration is the means whereby such controls are made possible.

Capable, ethical engineers were quick to realize that registration would benefit them by reducing the frequency of incompetency in the profession, by furnishing a means to control (or eliminate) incompetent or unethical practitioners, and by raising the general level of the profession as a whole. Therefore, the engineering profession (in all its branches) has not fought registration, but has backed it, has endeavored to make it more and more difficult to become registered, and has attempted to shape registration laws which offer stronger control measures.

Engineering registration laws, in some form, are in effect today in all of the forty-eight states, in the District of Columbia, and in Hawaii, Puerto Rico and Alaska. There is no uniformity among these laws, particularly as they pertain to industrial engineers.

While a detailed discussion of these laws is beyond the scope of this article, a few comments may be of interest.

A fair portion of the laws require a degree from a recognized college or university and four or more years of experience to qualify for registration. Many, if not all, of the states allow for the substitution of additional experience in lieu of college training. All experience must be bonafide and acceptable.

Some states require only the presentation of evidence of education and/or experience, plus suitable character references to become registered. Others require such evidence and the passing of a written, or a written and oral, examination in order to become registered.

Some states recognize various branches of engineering, others do not. Of those states which recognize branches, some recognize industrial engineering as a separate branch, while others do not. The various state laws have been classified according to the manner in which they recognize the various branches as follows:

A1. Laws which do not recognize or designate specialties or branches of the engineering profession, but which have a special examination for industrial engineers. Florida, Kansas, Missouri, Pennsylvania, Rhode Island and Tennessee have such laws.

A2. Laws which do not recognize or designate specialties or branches of the engineering profession, and which do not have a special examination for industrial engineers. Such laws may not, in fact usually do not, adequately take care of industrial engineers. Colorado, Delaware, Illinois, Nebraska, New Jersey, New York, North Carolina, North Dakota, Wisconsin and Wyoming fall in this category.

B1. Laws which recognize and designate specialties or branches of the engineering profession, and which recognize industrial engineering as such a specialty or branch. Alabama, Arizona, Arkansas, Connecticut, Georgia, Iowa, Kentucky, Maine, Michigan, Nevada, New Hampshire, New Mexico, Ohio, Oklahoma, Oregon, South Carolina, South Dakota, Texas, Utah, Vermont, Virginia and Washington are included in this group.

B2. Laws which recognize and designate specialties or branches of the engineering profession, but which do not recognize industrial engineering as such specialty or branch. California, Idaho, Indiana, Louisiana, Maryland, Massachusetts, Minnesota, Mississippi and West Virginia have laws of this type.

AIIE is working to get those states whose laws are of type A2 and B2 to change their laws to give suitable cognizance to industrial engineers. Our preference is for

laws of type A1, although laws of type B1 do not displease us.

Each engineer should familiarize himself with the registration laws of his own state, and take steps toward registration accordingly. There is someone near each of you who can help you if you need help. Your Committee on Professional Registration has regional and chapter members who are willing and qualified to help you. If your chapter is not represented, speak to your chapter president about it!

The registration movement has gained considerable momentum during the past two decades and has by no means reached its peak. An ever increasing number of engineers are coming to realize that their own individual well-being is inextricably interwoven into the well-being and progress of the profession as a whole. They are becoming registered in increasing numbers, and are championing registration and professional status for the entire community of engineers.

Perhaps a few facts and figures may be of interest and highlight the impetus which the registration movement has attained.

The first registration law in the nation was passed by Wyoming in 1905. The last registration law in the nation was passed for the District of Columbia in 1950.

In 1930 there were only about 10,000 registered engineers. It is estimated that today there are 200,000 registered engineers in this country and the number is growing steadily.

Industrial engineering is the most rapidly growing branch of the engineering profession. From 1940 to 1950 industrial engineers increased from 9,800 to 46,700, or by 376% in the ten-year period. The nearest approach to this record was achieved by the chemical engineers who increased by 168% in the same period.

An opinion survey of its membership made in 1955 by the National Society of Professional Engineers revealed an almost unanimous vote in favor of more rigid registration laws and of written and oral examinations plus broader experience for registration qualification.

During 1955 at least three states revised their registration laws to make them tougher. At least two other states are now redrafting their laws with the same end in view.

An increasing number of companies who employ engineers are encouraging registration among their employees. Some are demanding registration as a prerequisite to employment at higher salary levels. At least one major manufacturer requires that an engineer be registered before he can be advanced to the more responsible positions and the same company insists that each such engineer place his professional seal on his work, even though that work is wholly an intra-company matter.

So you see that registration is not something of interest to consultants or educators only. It is becoming increasingly vital to every engineer regardless of where he works. In fact there is a distinct possibility that the federal government will soon require Civil Service engineers to be registered in order to qualify for high-level jobs.

Next, let's talk about earnings. Approximately 40% of the doctors and 30% of the lawyers earn $10,000 or more per year while less than 10% of the engineers earn that much. Could the fact that those professions have been more closely regulated, more rigidly controlled by legal requirements and more uniformly organized than the engineering profession have anything to do with this great disparity in earnings? I believe firmly that it has a lot to do with it.

I believe that *all* engineering societies are committed to encourage registration. Certainly our own AIIE is so committed. I further believe that it is only a matter of time before registration will be a prerequisite to full membership in any of the engineering societies, including our own AIIE.

There is an increasing tendency to use the initials "P.E." after names in rosters of engineering clubs, societies, etc., and in other such listings, in order to designate those who are registered professional engineers.

Indeed, there are many good reasons why registration is desirable, and very few, if any, to the contrary. It costs little to become registered and less to renew your registration each year. Also, registration fees are deductible!

One thing is certain, the longer you wait the tougher it will be to become registered. The time to become registered is *now*.

These remarks have thus far been aimed at the man who is not registered, but who could be. I hope they have been so convincing that tomorrow State Boards throughout the nation will be swamped with applications for registrations from industrial engineers. But now I would speak to the younger men who cannot yet qualify for registration, to those of us who are already registered, and to the leaders of AIIE.

You younger men are the ones who will benefit most from registration and who are most in the thoughts of the older engineers who are leading and shaping the registration movement. Their thoughts are about you, not to try to exclude you, but to make engineering a better profession for you to be in. Most, if not all, states provide for the registration of qualified young engineers as "Engineers in Training". The purpose of such registration is to permit younger men to pass part of the requirements for full registration while their "book learning" is still fresh in their minds, and to simplify full registration when the required amount of experience has been attained. I cannot urge you strongly enough to become an "Engineer in Training" as soon as you can.

You older men who are registered and you leaders of AIIE, especially chapter officers—you have a definite responsibility in this matter. The young men and the older men who have not yet registered need guidance, assistance and encouragement along the road to registration. Give it to them. Give it to them wholeheartedly and unstintingly by forming a local committee or group which is well in-

formed on requirements and anxious to help those who seek help. Publicize its work!

Several of our chapters have such groups and are doing splendid work. They have sponsored refresher courses to prepare aspiring applicants for examinations. They have provided information and guidance of every sort (including questions of prior examinations) to those seeking help. They are alert to the politics affecting registration requirements in their home states, and seize every opportunity to influence legislation favorable to the registration of industrial engineers.

We need more such groups. We need one in every single chapter of AIIE, because much more can be done to foster registration at the local level than can possibly be accomplished by the combined efforts of your regional and national committees. So let's see how fine a job each of us can do in our own little bailiwick.

Each of us who becomes registered, and each of us who assists another to become registered helps to better the profession. And in bettering the profession we cannot help but better ourselves.

FINANCIAL STATEMENT OF AIIE

As required by Article VI, Section 28 of the AIIE Constitution, the following financial statement is published as prepared by our auditors, Keller, Kirschner, Martin & Clinger, Certified Public Accountants.

Statement of Cash Receipts and Disbursements for the year ended December 31, 1955

CASH—January 1, 1955			$ 9,652.37
RECEIPTS			
Application fees		$ 2,498.00	
Associate dues		16,111.46	
Senior dues		18,617.61	
Student dues		2,135.32	
Affiliates dues		1,726.09	
Sale of pins	$497.11		
Sale of certificates	84.00	581.11	
Sale of books and publications		954.97	
Journal subscriptions		1,726.59	
Chapter dues		10,803.98	
Conference and conventions		2,873.90	
Journal advertising		142.50	
Interest on savings accounts		144.85	
Miscellaneous income		101.42	
Total receipts			58,417.80
			$68,070.17
DISBURSEMENTS			
Salaries	$13,449.76		
Less taxes withheld—due January, 1956	208.36	$13,241.40	
Rent		1,562.50	
Telephone and telegraph		274.81	
Postage		1,474.81	
Stationery		347.30	
Journal		10,088.70	
Directory		1,039.84	
Printing		1,494.98	
Refunds of dues and application fees		189.95	
Travel expense		1,546.11	
Pins and insignia		711.24	
Office supplies		884.11	
Office equipment		1,287.09	
Office equipment maintenance		48.30	
Payroll taxes		392.95	
Insurance—health		64.95	
Insurance—fire		19.50	
Employee bonus		130.00	
Brochures		195.37	
Application forms		220.82	
Prizes and awards		40.00	
Convention expense		1,518.05	
Audit		95.00	
Chapter organization		170.03	
Mailing list maintenance		198.35	
Memberships		50.00	
Membership certificates and charters		38.70	
Chapter dues		8,854.53	
Constitution and by-laws ballot		116.94	
Journal advertising (cost of books—co-op)		549.75	
Refunds of Journal advertising income		24.08	
Joint Council expense		109.00	
Bank service charges		32.44	
Miscellaneous expenses and refunds		123.28	
Total disbursements			$47,134.88
CASH—December 31, 1955			$20,935.29

The above cash at December 31, 1955 consists of the following:

The Huntington National Bank—demand deposit	$ 3,695.39
The Buckeye Federal Savings and Loan Association—savings account	10,154.90
Ohio Federal Savings and Loan Association—savings account	7,035.00
Petty cash fund	50.00
Total cash above	$20,935.29

Maintenance of Time Standards

By Edward V. Krick

Department of Industrial and Engineering Administration, Cornell University

The time standard for an operation is dependent upon the method used and upon the conditions under which the task is performed. It is essential, therefore, that effective control of *changes* in these two factors be an integral part of the time study procedure. If significant adverse changes occur, such changes should be detected and the standard method and conditions restored. If restoration is impossible, a new standard should be established. If significant desirable changes occur, they should be detected, the new method and/or conditions standardized, and a new time standard established.

A management is being naive if it operates under the assumption that a job and its environment will remain "fixed" after the time standard has been established. Yet this is exactly the tacit assumption under which many present day managements appear to be operating. Actually the industrial shop is a very dynamic situation; dynamic materially, sociologically, and psychologically. A time standard becomes obsolete just as a piece of equipment does; in fact, the time standard is considerably more vulnerable to obsolescence than a piece of machinery. In addition, the obsolete time standard is usually less obvious to management than an obsolete machine. If a management is to prevent inconsistencies from creeping into the time standard structure, it must keep abreast of changes in methods and conditions in the shop. It should attempt to *prevent adverse* changes, *detect* changes, then *take appropriate action*.

There is no logic in striving to *set* more consistent time standards and then making little or no effort to prevent these same standards from drifting out of line *after* they are set. Many managements are making elaborate efforts to improve the consistency of their time standards, but in most instances they are concentrating these efforts on setting a more consistent standard, with little or no attention paid to preserving that consistency after the standard is set and installed. It does not take long for a time standard structure to develop numerous inequities if this maintenance function is neglected. The sensible approach is to submit time standards to an audit procedure that will maintain, as far as possible, their original consistency.

Administrators responsible for failing to adopt a maintenance procedure sometimes assume this position because they believe that the time standard structure is functioning satisfactorily without such control. Apparently these managers do not realize that their time standards may *appear* to be consistent when the true situation is quite the reverse. Evidence supports the contention that under a loose standard workers frequently regulate their performance so that their output will show the relationship to standard that is desired by management.[1] In this manner loose standards are made to appear satisfactory. This practice, commonly referred to as restriction of output,[2] can be surprisingly effective in concealing loose time standards and thus the true quality of the time standard structure. The following situation is probably more common than the above. Management is concerned over the quality of its time standard structure but does not realize that inadequate maintenance is an important, if not the most important factor causing the dilemma. In this case management fails to understand the true nature of its problem. In the author's opinion many managements, either because the problem is diagnosed incorrectly or because it is not even recognized, are neglecting this maintenance function when it would be much to their advantage to do otherwise.[3]

The reasons that some managements express for wanting more accurate methods of establishing time standards are the very same reasons why managements should be attempting to keep their existing standards as much "in line" as possible. Most of these reasons concern inconsistencies and their effects on costs through such situations as grievances, dissatisfaction and low morale, reduced effectiveness of the planning and control techniques in which time standards are utilized, and restriction of output. These same consequences should be expected regardless of whether a standard became inconsistent through change or whether it was inconsistent when established.

It is well known that some incentive wage installations have developed into costly headaches, causing the manage-

[1] Throughout this presentation, it is assumed that the time standard structure serves as the basis for a wage incentive plan (of the low task type).

[2] Restriction of output exists when the person considers factors other than tiredness he feels at the end of the working day, the effort and the monotony he experiences, his safety, and his health, in determining how much he will produce.

[3] One indication of this widespread disregard is the fact that the necessity for such a function is rarely mentioned by writers in the time study field. In fact, it is never mentioned in any of the more widely distributed books on time and motion study.

ments to discard or wish they could discard the entire program. There is reason to believe that proper maintenance of time standards could have preserved some of these malfunctioning plans as the effective cost reduction devices they were intended to be. This is a contention worth serious consideration, particularly since the desirability of incentive wage plans is becoming increasingly uncertain.

Concerning the need for maintenance of time standards one author (1) has this to say:

"The difficulty is to keep track of minor changes that often go unnoticed and are usually made by the operator. Workers tend to hide these innovations and use them to produce more or to 'take it easy' on the job and keep production at the original level. This gradual loosening of rates creates resentment among those workers who are on jobs that do not lend themselves to such changes. Thus . . . a regular reexamination of jobs and standards is needed.

Where major changes in method occur, it is simple and feasible to revise the standard. However, cases frequently occur in many plants where a succession of minor changes on a given job have been unreported due to the small effect of their change. The cumulative effect leads to abnormally high earnings and when the standard is finally changed, the worker feels that an injustice has been done."

Another author (2) says:

"It is common practice to forget all about an incentive plan (and the time standards) after the initial installation except for annual or some other set period check-up. At these periodic intervals attempts are made to take up all the slack that has occurred in the interim. This means that loose standards are tightened for no apparent reason other than that a date has been reached. The changed conditions that made the standard loose may have been in effect for months. It is very difficult to convince the average worker that the standard should be changed at that later date. Thus the plan has become unbalanced and ill-fitting, with all the problems of its administration such a situation involves."

A point brought out in these excerpts bears further mentioning. If there is a long delay between the time a method improvement is made and the time standard is reset, the worker is prone to view the adjustment as a "rate[4] cut", resulting in violent objection. If the rate is changed at the time the method change occurs, the connection between the two changes is apparent, providing less opportunity for such objection and dissatisfaction.

It is important then, not only that the standard be reset but that it be done at the time the method change is made. Therefore, the company should not rely upon chance or upon excess earning reports to locate improvements, for these methods are very undependable and usually result in an undesirable delay. Rather, it should adopt a maintenance procedure which will offer reasonable assurance that improvements will be known before or at the time they are made.

Some method changes affect performance time to such a small degree that no adjustment in the standard is justified. Therefore this question arises: To what degree must a method change affect performance time to justify an adjustment in the standard? This is determined by that degree of change at which the costs involved in retaining the obsolete standard become larger than the costs of making the adjustment. This is a very difficult matter to quantify even in a general way. Until a useful estimate becomes available, management must use its judgement in selection of this minimal effect. Regardless of the point selected, whenever a change occurs that apparently does not justify an adjustment, it is essential that the nature of the change and its estimated effect on performance time be *recorded*. Then, when the cumulative effect of such changes becomes sufficiently large, the standard should be adjusted accordingly.

Summarizing, if we are to prevent the development of serious inequities in the time standard structure, if we are to keep our time standards representative of current methods and conditions, we must keep abreast of *change*. This is the main objective of the maintenance procedure. The Time Study Department must keep informed about changes in method and conditions and take appropriate action, otherwise the time standard structure will gradually decay, bringing dissatisfaction to both labor and management.

The Time Standard Maintenance Procedure

There are two phases to the proper maintenance of a piece of equipment. First there is the continuing attention that is given the machine to prevent or postpone a failure. This is usually referred to as preventive maintenance. The second is the restoration of a piece of equipment to working order after a breakdown. The latter may be described as the repair-replacement phase of maintenance.

These same phases emerge in a maintenance program for time standards. In this case the preventive maintenance phase comprises specific steps designed to minimize the chances of a "breakdown" (tightness or looseness due to change). The repair-replacement phase comprises certain remedial steps[5] that should be taken when a tight or loose standard is discovered. These components will subsequently be described in detail.

An important difference between the breakdown of a piece of equipment and the breakdown of a time standard is that the latter frequently occurs and remains without the knowledge of management, a situation which can hardly exist in the case of equipment. When the breakdown of a standard goes undetected the necessary repair or replacement is not made; instead another inconsistency is added to the time standard structure. The ease with which breakdowns can go unobserved makes it necessary to add a third phase to the maintenance of a standard. This will be referred to as the detection phase and its main purpose is to bring to the attention of the Time Study Department, standards which have become tight or loose as result of change.

[4] The terms time standard, standard, and rate will be used interchangeably in this paper.

[5] Such as restoration of the standard method or conditions, resetting of the rate, further training of the operator, etc.

To summarize then, there are three phases to the maintenance procedure about to be described. They are:

Prevention: There are certain steps that management should take to minimize the chances that a time standard will become "out of line" after it has been established.

Detection: Management should utilize certain techniques and procedures to facilitate the detection of instances where change has caused the standard to become tight or loose.

Remedy: When a tight or loose rate is located, appropriate remedial action should be taken. In the case of a tight standard:

1. If the tightness is due to a change in the job made since the rate was set, if logical and possible the original method or conditions should be restored; otherwise the standard should be reset.
2. If it is a case of an unsuited, inexperienced, or improperly trained operator(s), the standard should remain unchanged. Instead, appropriate corrective action should be taken with respect to the operators involved.

In the case of a loose standard:

1. If the looseness is due to an improvement in the operation that improvement should be standardized and a new time standard established. If the improvement originated with the operator he should be rewarded appropriately for it.
2. If the looseness is due to disregard of a quality requirement, this requirement (if really necessary) should be enforced and the standard left untouched.

Preventing Standards from Becoming Tight or Loose

Most plant engineers believe that substantial dollar savings may be achieved through proper preventive maintenance of equipment. The writer believes that considerable dollar savings may similarly be obtained through proper preventive maintenance of time standards. It appears more economical to take steps that will minimize the chances of standards becoming tight or loose than to face the higher costs of grievances, loose rates, low morale, restriction of output, malfunctioning planning procedures, etc., that result if such steps are ignored. It is highly recommended that managers carefully consider the economics involved in this situation.

Discussed below are the steps in this preventive maintenance procedure. These recommendations are directed at the period which begins immediately after the standard has been established. They are precautions designed to *minimize* the chances of a rate becoming tight or loose *after* it has been set. Note that most of these steps have advantages other than the one cited here. In most cases these other advantages are ample justification in themselves for applying the recommended measures.

1. Make an attempt, as extensive as economy will allow, to **improve the method** *before* the standard is set. Of the benefits received from this practice, the one of particular interest here is that there will probably be fewer improvements made *after* the standard is set. Every management should be following this practice if only for the dollar savings that are to be gained through less costly methods of operation. This alone is ample reason. But in addition, here is one of the most effective steps that management can take to prevent standards from becoming loose. There are no rational excuses to be offered by any management for not being actively engaged in methods improvement, yet one finds that neglect of this important step is widespread in industry today. Observations by the author and his associates indicate that a majority of plants are establishing most time standards without making a serious methods study beforehand. Plants that conscientiously follow the recommended practice seem to be the exception rather than the rule.
2. **Improve the conditions** surrounding the job *before* the standard is set. Reducing the number and duration of delays to a minimum is particularly important. Also included is the establishment of a suitable level of lighting, temperature, ventilation, noise, etc.
3. **Standardize the method and conditions** before the rate is set. Since performance time is dependent upon these two factors, it is essential that they be stabilized *before* a time standard is established and installed. Failure to do this is an invitation to the development of inconsistencies.
4. Make a **detailed record of the method and conditions** upon which the time standard is based. This information should include:
   a. An adequate description of the motion pattern, by elements;
   b. The specifications of incoming and outgoing materials;
   c. The quality of incoming and outgoing materials;
   d. The equipment used;
   e. Speeds, feeds, etc.; and
   f. The conditions that existed when the time study was made.
5. Obtain a maximum amount of benefit from the **instruction sheet** by making it a detailed record of the method upon which the time standard is based. It should include the information listed in step 4 and the standard time for the operation, to encourage all personnel to associate that time with the method shown and vice versa. In addition, supervision should use this record as a basis for periodic checks of the method to determine whether changes have taken place. To facilitate and encourage this use, the title of this record should be changed from Instruction Sheet to a name such as Standard Method Description. With the present title people are prone to think of this sheet as intended for instructional purposes only. By this change in name we hope that the users will get the impression that the usefulness of this record begins, not ends, with instruction. The purposes of the Standard

Method Description should be clearly stated on the form.

To increase the chances that obsolescence of a standard will be recognized when it occurs the following provision is suggested. If at the time the standard is established the analyst is cognizant of a characteristic of the method that is quite likely to change and make obsolete the standard, attention should be drawn to this possibility in the "Standard Method Description".

To observe present industrial practices with respect to the Instruction Sheet one gets the impression that few industrial engineering departments understand the full purpose and potential usefulness of this form.

6. **Educate supervisory and staff personnel,** particularly foremen, as to their responsibilities in maintaining the time standard structure. This educational program should stress:
   a. *The importance of keeping standard* the method and conditions of the operation. Of course, we want the supervisor or staff member to restore the method and conditions to standard only when the change has been an adverse one, for example, worn machine bearings. When the change is a desirable one, such as an improvement in method, or when it is an adverse change that cannot be rectified for the time being, the fact should be reported to the Time Study Department so that the standard can be checked and adjusted if necessary. The second point to be stressed then is:
   b. The *importance of reporting changes* in method and conditions to the Time Study Department. This refers to the desirable changes and the adverse changes which cannot be rectified. It is particularly important that supervisory, engineering, methods, quality control, plant layout, maintenance, and tool design personnel be urged to cooperate in this respect.
   c. The *importance of the foreman's cooperation* to the success of a standards maintenance program and in turn, the importance of such maintenance to the quality of the time standard structure and the techniques in which it is used. Without his support several of these preventive steps will be to no avail, others will be seriously hampered.

   To help the foreman understand and carry out his part in maintenance of time standards it is recommended that he be *well* informed as to the functions of and procedures used in time study. A series of training sessions seem well worth the investment for this and many other purposes.

   In summary, one of the most vital of the preventive maintenance steps is assuring that supervisory and staff personnel know their responsibilities in the upkeep of the time standard structure.
7. Establish a successful **suggestion plan.** In addition to the advantages usually associated with such an arrangement, it also plays a part in the prevention of loose rates. The operator should at all times be encouraged to develop an improved method of performing his job. He should *also* be encouraged to submit his idea under the suggestion plan to be rewarded directly for it. We do not want him (or others) to use his improvement under an unchanged time standard. A suggestion plan with *sufficient rewards*, reasonable policies, and adequate publicity should aid in achieving these objectives.
8. Establish a **routine paper procedure** which notifies the Time Study Department of changes in method or conditions that may affect performance time. A three by five inch slip of paper will suffice. The form itself should be very simple, requiring only a fraction of a minute to fill out. Supervisory and staff personnel should be required to use these slips to inform the Time Study Department of changes that may affect the time standard. Shown below are most of the intended users of these forms along with a sample of the type of information that the forms are designed to convey from each:
   a. *Foremen*—Unavoidable increase of the delays in the arrival of raw stock for an operation;
   b. *Quality Control Department*—Unavoidable decrease in the quality of raw stock;
   c. *Engineering Department*—Redesign of a part;
   d. *Methods Department*—Redesign of an assembly fixture;
   e. *Maintenance Department*—Installation of a new machine.
9. If applicable to the type of operations involved, use a system of **predetermined motion times** to establish time standards. The advantages of using such a technique that are of interest here are:
   a. The method *must* be considered in detail during the study to determine a standard. Therefore the probability that improvements will be discovered before the rate is set is greater than it is when the stopwatch time study is used. Unfortunately it is too easy to set a time standard with the method just "as is" when the stopwatch technique is used.
   b. A detailed description of the method upon which the standard is based *must* be made when the standard is set. Thus when changes in method eventually occur they will be easier to detect and verify.
   c. Persons trained to use one of these systems are more apt to recognize the need for adjustment of the standard when the method is changed.
   d. The effect of a method change on performance time may usually be determined more conveniently and more rapidly than under the stopwatch procedure. Consequently there will be less tendency for the time study man to ignore the effects of changes in method.
10. **Establish responsibility for maintenance** of time

standards. Fixing of this responsibility is essential if the maintenance procedure is to succeed.

Summary

The number of standards that become tight or loose after they are set may be minimized by following these recommendations:

1. Attempt to improve the method before setting a standard;
2. Attempt to improve the conditions before setting a standard;
3. Standardize the method and conditions before setting a standard;
4. Make a detailed record of the method and conditions as they exist when the time study is made;
5. Use the Instruction Sheet to best advantage;
6. Educate supervisory and staff personnel as to their responsibilities in maintenance of standards;
7. Establish a successful suggestion plan;
8. Establish a routine paper procedure;
9. Use predetermined motion times to establish and revise standards;
10. Fix responsibility for maintenance.

A criticism that may be directed toward several of the above recommendations is that they tend to stifle improvement in manufacturing methods and processes. Repression of improvement is, of course, not an objective of this preventive maintenance procedure nor is it a necessary consequence. It is conceivable that such a result could occur through incompetency or improper emphasis in execution of the suggested practices.

Detection of Standards That Have Become Tight or Loose

The procedure described below is designed to bring the Time Study Department's attention to standards that have become out of line because of changes in the job. Such a procedure is recommended because some standards will eventually become inconsistent in spite of the best preventive efforts, (and to be sure, not all standards are consistent when they are set).

In brief, a tight or loose standard might be detected via its cause or via the operator output pattern under that standard. In the former method detection is accomplished by locating the situation which is causing the tightness or looseness. In the latter it is accomplished by noting from the production records of operators on the job, certain trends in output which appear to be indicators of tightness or looseness. These two methods of detection are described below.

Detection of Tight and Loose Standards — Via the Cause

Many of the standards that are set tight or later become that way are brought to management's attention by operators on the job. Unfortunately however, operators are not always aware of the situation when their standard is tight. In addition, many operators complain about a "fair" standard in an attempt to have it loosened. Therefore, the problem in the case of tight standards is one of detection in some instances, of verification (of a claim) in others.

One method of detecting or verifying a tight standard is to find the cause of tightness. For example, assume we know that burrs on parts cause an increase in performance time for a certain assembly operation. If investigation of a protested standard for that operation reveals that the percentage of parts with burrs has increased since the rate was set, we conclude that the standard is tight. Most of such changes are reported to the time study department by the operator, either directly or through the foreman.

It is also possible to detect a loose standard via the cause. As previously recommended, the time study department should establish a formal communication channel with supervisory and staff personnel, to assist it in keeping informed of such changes. Furthermore, operations should be *periodically checked* against the "Standard Method Description" to determine if changes have taken place. A periodic review of this type should be particularly effective in diminishing the effects of "creeping changes".

Detection of Tight and Loose Standards Via the Performance Pattern

Attempting to detect an inconsistent standard by interpretation of the *level* of output is an unreliable procedure, particularly so in the case of looseness. This is so because of the vagueness and subjectiveness involved in evaluation of worker skill and effort, because of the prevalence of restriction of output under loose standards, and because of the small sample sizes (number of operators performing the operation in question) usually involved.

In light of these circumstances only the following general recommendation may be made. If the grand average performance[6] is very high or very low, the standard might be investigated for causes of tightness or looseness. However, an abnormally high production efficiency does not assure that the standard is loose, nor does an abnormally low efficiency assure that the standard is tight. And most important, the absence of such abnormal values certainly does not mean that the standard is not tight or loose.

Although the level of output under a standard is an unreliable indicator of its satisfactoriness, there is another characteristic of the performance pattern which might be useful in the isolation of a loose rate protected by restriction of output, the most serious problem in detection of poor standards. This characteristic is the variability of output.

There is some opinion and logic (3) to support the following hypotheses:

1. When output is restricted the variation *between* operators is less than would ordinarily be expected.

[6] Average for the group performing the operation in question, over a prolonged period.

2. When output is restricted the variation *within* operators is less than would ordinarily be expected.

If these hypotheses are true, then it will be possible to detect loose standards protected by restricted output by being alert for instances in which variation is suspiciously less than would ordinarily be expected. Unfortunately, however, there is not enough information available for proper evaluation of these postulates, so that it is not known whether or not we are justified in using them. To establish their value will require extensive investigation of output rate phenomena, particularly as it is affected by different motivational states.

To encourage and assist the collection and interpretation of data required for this research, several graphical methods of data presentation are described below. These same methods will also serve as practical methods of maintaining an alertness for lack of output variation, the usefulness of which is of course contingent upon acceptance of the above hypotheses.

The Operation Histogram

If there is a relatively large group of persons performing an operation, a production average[7] may be obtained for each operator for a period of weeks, months, or lots, and these plotted in the form of a frequency histogram. To facilitate the comparison of such plots and to assist in avoiding errors in interpretation, it is suggested that the high end of the scale be located to the right whenever the abscissa is output, to the left whenever it is time. Shown in Figure 1 is an Operation Histogram of production averages for twenty-three piecework operators assembling cardboard partitions for cartons. Each operator's average was computed from daily production figures for twenty-two consecutive working days.

It is not often that the number of operators performing an operation is large enough to permit the plotting of this type of histogram. However, it is an approach that might be used to view en masse the production averages in a given department, or for a given type of operation, or those set by a particular time study man.

The Operator Histogram

This is a histogram representing one person's performance over an extended period of time, as shown in Figure 2. If a device of this type is to be used to reveal lack of variation in a person's performance, then it is important that we give variation every opportunity to appear if it is really there. Therefore, the output period upon which this plot is based should be a day or lot, whichever is shorter. If output for a longer period were to be used we would not expect much variation in performance between successive periods even if the normal daily variations were present. Such variations would have an opportunity to average out over longer intervals. An output period of less

[7] In output per unit of time, such as parts per day, or in percent of standard.

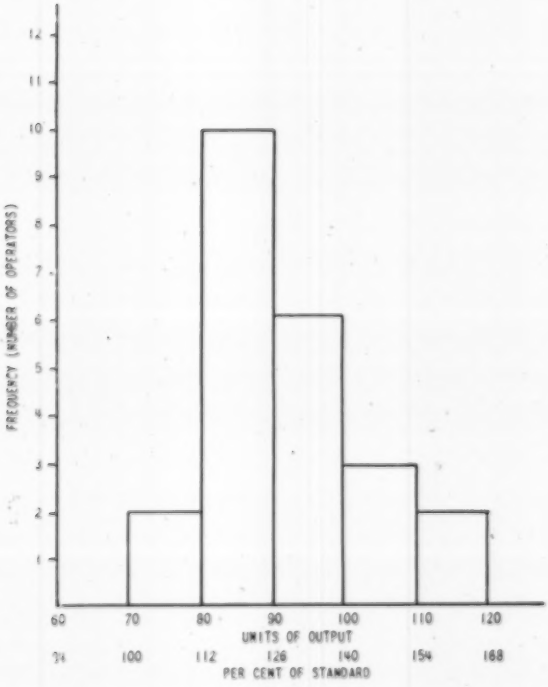

FIG. 1. Operation histogram

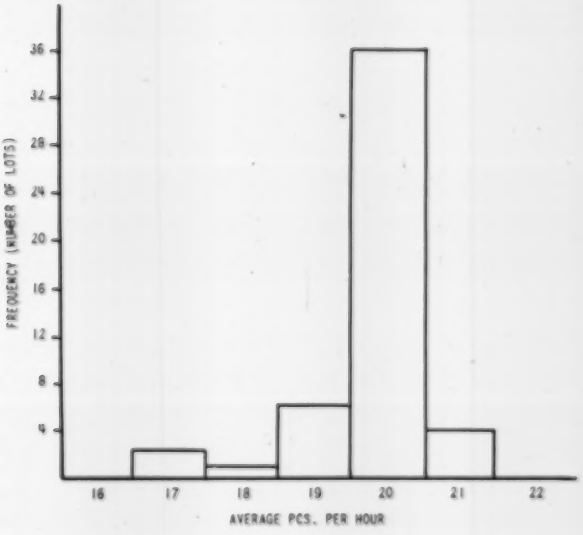

FIG. 2. Operator histogram (assembly operation)

than a day is not practical for data collection purposes, nor is it desirable, for it seems that many people restrict production on a daily basis.

Performance Chart

Another technique providing a graphic portrayal of the individual's output variability is referred to as the Performance Chart and is demonstrated in Figure 3. The abscissa is chronological, the ordinate is production rate or some index of it. If more than one operator's production is plotted on this chart, it is suggested that the output of each be plotted with a distinguishing color or symbol.

Pooled Histogram

A frequency histogram is readily made from a Performance Chart, in fact it may be done quickly and conveniently on the same graph as shown in Figure 4. First, turn the Performance Chart on end so that the production rate scale is now at the bottom. Now construct on the left a new ordinate scale, frequency of occurrence. Next, determine from the points already plotted on the Performance Chart the frequency of occurrence of each production rate and from this information plot a histogram on the new axes. If the range of production rates is not large and if there is enough data, each value on this scale may be treated as a cell, otherwise they must be grouped into cells. When the output data for all individuals on the operation are combined in this fashion, the result will be a composite picture of the variation between and within individuals on that job. Since it requires the pooling of operator output data it has been referred to as a Pooled Histogram.

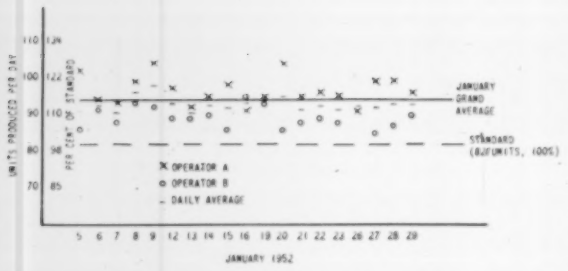

FIG. 3. Performance chart (sewing operation)

Summary of Detection Procedures

Detection of tight and loose rates via the performance pattern is not a successful procedure at the present time. Use of the level of performance is unreliable, especially so in the case of loose standards. The variability of performance is promising in this respect, but in order to be sure of its practical value more must be learned concerning the variability to be expected under different motivational states.

Maintenance Of Time Standards—A Summary

A time standard structure, like machinery, will lose its effectiveness at a rapid rate unless it is properly maintained. The obsolescence of time standards means unsatisfactory results in manufacturing planning and control, and from the wage incentive plan. To minimize the decay of a time standard structure it is essential that management take steps to minimize the chances of obsolescence, to keep informed of the status of its standards, and to make adjustments as dictated by changes in plant methods and conditions.

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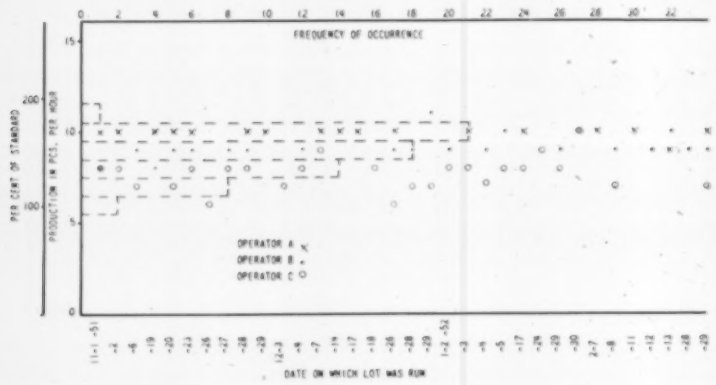

FIG. 4. Performance chart and pooled histogram

Industrial Engineering in the Post Office Department*

By Joseph C. Nickels

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The United States Post Office Department is another new field being invaded by the industrial engineer. Here is a business providing service to more than 160 million customers; employing a half-million workers to man postal installations in each city, town, and village in every state and territory; and having an annual revenue in excess of 2¼ billion dollars. It is a business that shows a phenomenal growth year after year—just in the past 15 years mail volume has increased nearly 100%. Right now the postal service is handling more than 52 billion pieces of mail per year. It provides a vast communication network having a direct bearing on the lives of every citizen and every business in our country, and, through its international aspects, a tie-in with every nation in the world.

But that is only part of the picture. By 1953 our ever increasing population and our constantly expanding national economy had increased mail volume to such an extent that the existing postal machinery was in imminent danger of collapsing under the load. And the cost of processing mail had mounted to the point that the postal deficit was running nearly ¾ of a billion dollars per year —a loss of about 2 million dollars every day of every week.

In 1953 the new management team in the department decided to take action. Relief from immediate pressures had to be provided and, in addition, the groundwork laid for a postal system flexible enough to handle the continuing increases in the flow of mail anticipated for years to come.

The corrective action decided upon involved two basic approaches: 1. reorganization and 2. modernization.

Decentralization of Centralized Authority

The most important phase of the reorganization plan is the decentralization of managerial authority. Over the years, tighter and tighter centralized control of every phase of postal operations had reached the point that even minor decisions had to be made in Washington. In fact, delays in reaching decisions were so lengthy that 10-cent problems were growing into thousand-dollar crises before action was taken. Actually, the postal establishment was in danger of strangling on its own red tape unless management authority was decentralized.

The most important phase of the decentralization program of the Post Office Department involves the establishment of 15 regional offices in carefully selected parts of the country. These offices are being staffed with experienced postal people having an intimate knowledge of local conditions and local problems. These regional office personnel have been delegated the authority necessary to administer and manage post office matters at the local level.

Not all the emphasis, however, is being placed on the purely administrative and fiscal aspects of management—it is proposed not only to lower costs but also to provide better service to postal patrons and better working conditions for ½ million employees.

Modernization

The second basic approach decided upon was a program of modernization. Modernization is badly needed throughout the postal system. In far too many post offices, employees working in inadequate buildings are trying to handle today's mail with yesterday's equipment and procedures.

To spearhead the modernization, the Office of the Chief Industrial Engineer was established in November 1953. This newly-created office was charged with the continuing responsibility of providing department officials with technical staff assistance in the application of modern industrial engineering techniques to postal operations. As regional offices were established and staffed, industrial engineers were included as integral parts of the regional management teams and are responsible for all industrial engineering functions in their respective areas.

Recruiting competent industrial engineers to staff both our headquarters and regional offices has been complicated to some degree by the fact that many of the specialized industrial processes commonly found in private factories are not present in the postal service. The Post Office Department processes no raw materials, manufactures no product, and has no control over volume. It is basically a collecting, sorting, transporting, and delivery business which handles more mail than all the other postal systems in the world combined. Our staff members, therefore, must

*Based on a presentation to the East Tennessee Chapter of AIIE, March 24, 1955.

occupy relatively the same position in the engineering profession as do family doctors in the medical profession—that of general practitioners rather than specialists.

And since our men are not primarily theorists but are engaged in the practical application of industrial engineering techniques to very real operating problems, they rub elbows daily with all levels of postal personnel. All our engineers need that intangible human touch essential to successful management-employee relationships.

When all 15 regional offices are established, organized, and staffed, the scope of our industrial engineering responsibilities and activities will encompass all phases of postal operations, in all types of postal installations, in all parts of the country.

Meanwhile part of the staff is engaged in such work as determining the fixed and portable conveyor equipment and layout requirements necessary to handle all types of sacked mail (bulk mail) speedily and safely; developing new materials handling techniques and procedures; and developing functionally designed vehicles, carts, and containers to mechanize mail delivery insofar as is practicable. And, of course, as these new equipments are developed, we must write new or rewrite old procurement specifications to insure that manufacturers provide us exactly what we need.

And since employees can be expected to use intelligently new equipment and procedures only to the extent that they understand them, other staff members are busy writing standard operating practice manuals and technical instructions. In addition, we expect to provide technical training to postal employees in order to develop new and sharpen old job skills.

All in all, I feel that our infant industrial engineering organization has, in a relatively short time, made considerable progress toward the Postmaster General's goal of modernizing the postal service.

We have been concentrating on several major projects requiring immediate study, which promise to produce maximum economies in fairly short order.

New Vehicles

One of the major efforts is our vehicle program. The Post Office Department is one of the nation's largest users of motor vehicles, the big majority of which are standard light and heavy duty trucks of conventional design difficult to work from and costly to operate and maintain.

Our engineers, in cooperation with representatives of the automobile industry, have designed a series of specially designed, light weight vehicular units which will enable the carrier to perform much of his mail collection and delivery work on wheels and in comfort. To study these new vehicles, we established in Miami a test track with letter boxes spaced at various given distances. On this track we analyzed the time and effort expended by foot carriers as compared to carriers using bicycles, scooters, ramblers, jeeps, station wagons, and trucks of functional design. As a result of our findings, 300 of the 3-wheel scooter type vehicles have been placed in service in Florida and 250 sit-stand trucks with right-hand drives are in use in the Ohio area. These machines have speeded up mail delivery at the same time they have made the work easier. And cost analyses indicate that they are considerably less expensive to operate and maintain. Carriers working routes in congested areas cannot always use motorized vehicles. We have equipped some of these carriers with "caddy" type carts which enables them to transfer the loads from their backs, thus not only reducing fatigue but increasing productivity.

Conveyor Systems

Developing new and modifying presently available fixed and portable conveying systems and other materials handling equipment to speed the flow of "bulk" mail in and out of post offices is another of our major projects. During the past two fiscal years, the Department has spent nearly 1½ million dollars in developing and installing this type of equipment. Expenditures during the fiscal year 1955 for heavy duty loading-unloading portable conveyors, fork lifts, dock boards, skids, pallets, tractors, battery charges, and other materials handling equipment will total at least another million dollars. By eliminating much of the present "manhandling" of bulk mail, we expect to recapture the cost of this equipment in a reasonable length of time. And before leasing new postal facilities, plant engineering principles will be applied to help insure that new buildings permit effective mail handling operations with a minimum of manual labor.

Reduction of Drudgery

One of the most tedious, monotonous, and expensive jobs in the postal service is that of "facing" mail—"facing" is the term we use for the necessary operation of prepositioning letter mail prior to running it through the canceling machine to insure that the machine hits the stamped corner and not some other portion of the letter. A research company has been working on an automatic facing machine since September 1953. The laboratory phase has been completed, and the machine is being tested with live mail. There are still problems to solve and many wrinkles to iron out, but I think we're well on our way to taking the drudgery out of mail facing. In the not too distant future, we should have a machine, manned by 3 or 4 trained postal technicians, capable of facing 25,000 letters per hour.

After letter mail has been canceled, the next step in processing it is the sorting operation. Sorting mail is a mass clerical job requiring a small army of postal clerks. The letter you send to a friend in a distant city first goes through the "outgoing primary," that is, separation by the name of the state to which it is addressed; then it moves to the "outgoing secondary," that is, broken down to the designated city within that state. When it reaches your friend's local post office, your letter undergoes "city primary" and "city secondary" separations, which means

that it is broken down to the postal station and the individual carrier serving the addressee's residence. These are only the basic separations involved in getting your letter delivered to its ultimate destination and I am sure you will agree that you are getting your money's worth out of a 3-cent stamp. At any rate, this job of sorting mail is a major and complex problem.

The Mail Sorting Problem

Present procedures require the use of several groups of labeled cases for each type of outgoing and incoming separations. As a result, we have row after row of sorting cases on postal workroom floors which compounds the perennial, and sometimes critical, space problem.

Post Office engineers have developed an experimental sorting case which is being thoroughly tested in post offices of various sizes. The standard sorting case has been enlarged and so modified that a postal clerk can obtain more separations from the initial reading of the address when he first handles a letter. Obviously, any increase in the number of separations each time a letter is handled will reduce the number of sorting cases required thus releasing badly needed floor space.

Improved sorting cases, however, are not the final answer to the mail sorting problem. We believe that the ultimate solution lies in the realm of automation and eventually we expect to come up with a machine which will automatically read typed or printed addresses and automatically sort mail so addressed. One of our contractors is moving ahead on the basic research essential to the development of a prototype automatic reading and sorting machine. Some progress has been made, but completing this project will take time and a lot of hard work.

Pending the development, production, and installation of these automatic machines, we are doing something to make the work of the sorting case clerk a bit easier and more comfortable. Included in this program are the improvement of seating facilities, installation of modern illumination, and repainting of interiors with restful, easy to look at colors.

Packaging Bulk Mail

Using canvas sacks to package bulk mail has never been a wholly satisfactory method. Our engineers have developed model wooden and metal containers which are now undergoing full scale tests. As we gain the experience necessary to solve the many problems and develop sound procedures, it is our plan to expand the use of container equipment as a substitute for mail sacks, particularly for local use. Developing containers for long-haul service must necessarily be a lengthy project since extensive changes to present receiving and handling facilities will be required before we can go far in that area. One interesting and potentially profitable phase of this container project is the development of a paper sack for the one way shipment of mail to Alaska and perhaps to Puerto Rico. These one-time-use or throw-away type paper sacks will eliminate the expensive return shipment of tons of excess empty mail bags.

Contributions of Customers and Employees

In the area of systems and procedures, we are intensifying our efforts to induce heavy mailers to separate their local from out-of-town letters and tie them in separate bundles before mailing in order to reduce the pressure on our present sorting system. This program is now underway in 28 large cities and the results are most encouraging—a recent check disclosed that more than 3 million pieces of mail per day are by-passing the standard primary distribution cases. A manual of instructions for installing and operating this system has been published. We plan to extend this procedure throughout the postal service at the rate of two regions per month, which is the minimum time required to train local postal supervisors.

In order to do an adequate job of reviewing systems, procedures, and work methods, we need the help of all postal employees and their supervisors. We have a work simplification plan called "Methods Improvement" which we hope to get into operation soon. This program is an organized plan of action aimed primarily at aiding first-level supervisors and their crews of employees to cooperate in improving and simplifying their own work methods. This has often been called a "from the bottom up" approach to operations improvement. Our proposed plan has been used extensively and profitably in both private industry and other Federal departments to eliminate unnecessary tasks and produce savings in manpower, material, equipment, and space. This program has also proved to be a good employee morale builder, primarily because supervisors and employees themselves develop proposed improvements in their own work situations.

Post Office Lobby Facilities

In addition to developing and procuring various equipments to handle the volume of mail more efficiently and faster, we are working on items designed to give better direct service to our post office lobby patrons. The much discussed post office pen has become something of a national joke. After testing many types, ball point pens have been distributed for trial use.

The patron waiting time at stamp windows will be reduced by the installation of stamp dispensing machines and accessory automatic cashiers at normally busy windows. Tests have shown that the use of these machines in unit sales of 20 stamps or less reduces the time per transaction by as much as 45%.

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Comments on the Analysis of the Less Repetitive Types of Work

By W. R. Hudson, Ph.D.

Associate Professor of Industrial and Management Engineering, State University of Iowa. Senior Member AIIE

Judging from the publication of case studies, there seems to be a growing interest in analysis of the less repetitive types of work. This interest is timely. A substantial portion of our work force is now engaged in work of this kind and there seems to be high likelihood that the proportion will grow in the future. The various factors tending toward shorter hours of work and higher pay, including automation, promise to increase the staffing requirements in service industries and to decrease the amount of repetitive manufacturing done directly by humans.

Unless he is prepared either to ignore the problems of planning and control of the work indicated above, or to rely on machine pacing to accomplish these functions, the industrial engineer needs to start, now, to examine the problems of methodology in analysis of the less repetitive types of work. Case studies are evidence both of healthy interest and of tangible accomplishment in this problem area. By their nature, case studies stand as individual undertakings and so do not serve of themselves to give us perspective of this *class* of work situation. This paper is intended as a beginning of a search for the characteristics and general methodology, for analysis of this increasingly important class of work situation, generally identified as less repetitive. This will be done by first stating at the fundamental level the requirements to be met, then considering the methodology for meeting the two most challenging requirements.

As the starting point, a generalized statement of the mission of the industrial engineer is proposed: "Through analysis and measurement to construct tools for use in improving the direction and control of organized effort in human institutions".

From this statement it follows that:

1. The industrial engineer is primarily a maker, not a user, of tools for direction and control. These tools are intended for use; therefore they must not only be technically feasible but also practically usable.
2. The use of the tools should result in improvement of the effectiveness of utilization of the human and or the material resources of the institution.
3. In order to carry out his mission, he must be able to accomplish the four prime stages of methodology, e.g. (a) observation, (b) analysis, (c) measurement, (d) synthesis or invention. In addition he must be operating in a general atmosphere such that the resulting "tools" will in fact be utilized.

Assuming that the foregoing statements completely cover the requirements, although in quite general terms, does it appear that anything in the inherent nature of the class of work situations under consideration would prevent accomplishment of the stated requirements? In considering an answer, it is to be remembered that unique obstacles in comparison with the familiar repetitive manufacturing situation are the matters of concern.

There appear to be two possible conditions which would prevent accomplishment of the mission, namely:

1. The activity is such that it cannot be observed, either directly or in terms of consequent activity. This would be the case of a mental activity not manifested by a representative and observable physical activity.
2. The pattern of activity is truly so random that no practically useful measurement is possible. This would be the case if repetitious and measurable activities were widely interspersed in small fragments among highly variable activities of condition (1) type.

From this, two statements as to limitations in the handling of the problem class of work are inferred:

1. The activities must be observable, either directly or as subsequently manifested representative physical acts.
2. The job must now contain, or be subject to rearrangement into, sufficiently long sequences of repetitious activities to provide an economically feasible basis for measurement.

There do not seem to the author to be any other limiting conditions due to the inherent nature of this kind of work. There are differences in methodology. These differences are largely in the relative importance of the techniques for observation, analysis, measurement, and for securing utilization. The observation and the measurement phases will now be considered.

Observation

Observation (including recording) of the nature of the activities comprising the job is likely to be much more of a problem than in repetitive manufacturing. The pattern of activity is very likely to initially appear almost completely random. Subsequent analysis may well reveal that the job pattern is not inherently and necessarily so random as it looked (and as the job incumbents believed it to be). Unfortunately, there can be no "subsequent analysis" unless the existing activity content can be observed and recorded

in necessary detail. Therefore, the problem is to employ the most economical observational technique which will provide the necessary level of detail.

Several techniques are available and have been successfully applied. Reported applications include:

Continuous observation—This technique is straightforward, easily understood, and can get a lot of information in a short time. It has several limitations: (a) in situations where the physical area is heavily loaded with workers it may not be feasible to introduce the required number of observers; (b) where the uninterrupted duration of each activity is short it is very difficult to fully account for all activities; (c) long spells of observing are fatiguing to the observer (and hence productive of errors) and are likely to become irritating to the workers; (d) it is frequently impossible to establish any definite assurance that all variations of activities have been observed; (e) skilled observers are likely to be required and considerable initial expense incurred.

Activity journal kept by the worker—This approach avoids the difficulties raised by outside observers but places an additional burden on the worker. Since the first duty of the worker is to the job, a dangerously large and often unknown proportion of the activities may be unreported as a result of pressure of the work. Again, establishing definite assurance of coverage of activities is difficult or impossible. Unless considerable care is taken in standardizing definitions and nomenclature, like activities may be recorded or interpreted as unlike, and vice versa. The approach does provide for immediate worker participation in the study.

Work sampling by human observer—This approach avoids the difficulties already mentioned but has some of its own. For best efficiency of the technique, the activities to be accounted for must be clearly defined in advance—but this is exactly what is not completely known. For this reason a "catchall" category is usually provided in which a substantial number of entries are likely to accumulate. This often means that additional studies must be made.

The observers do not need to be skilled as such, but complete understanding of the category definitions must be secured in advance. Other difficulties include: the necessity for someone on the project to have a sound knowledge of the statistical basis of the technique, and the difficulty in securing the workers' understanding and acceptance of the procedure.

Work sampling by motion picture camera—The combination of memomotion photography, the random interval timer, and work sampling produces a very powerful tool for observation. The technique avoids most of the difficulties mentioned so far but has its own limitations: (a) the area which the camera can "see" is small compared to that for a human observer although the detail it can see within that area is greater; (b) the level of normal lighting intensity; and (c) limitations imposed by the nature of the work being done may restrict use of the technique.

There is no universal best approach indicated for all situations. Selection of the approach is a matter of judgment just as in repetitive manufacturing. In any given total work situation a combination of the available approaches is often best. The point is that these observational techniques are available for use in analysis of the class of work under consideration.

Measurement

It is necessary to measure as well as to observe the components of a job or task. This is the phase about which least has been written and about which there is the most hesitancy in application to the less repetitive types of work. In the hope of contributing to clarity of thinking on the subject the author makes the following fundamental propositions:

1. It is necessary to measure fundamentally for only two reasons: (a) so that definite, quantitative values will be available for assessing the probable result of proposed changes in the work, and (b) so those who will use the resulting control "tools" can operate in terms of quantified reference points. "Standard time" is one of the forms in which this functional requirement is stated.

2. There is no universally necessary level of detail (or refinement, or accuracy) to which the measurement must be made. Strictly speaking, the proper level of detail will be determined by two factors, (a) the variance exhibited by the performance times, and (b) the absolute accuracy of the measuring instrument.

The level of refinement of the time measurement unit is not in itself a meaningful basis on which to judge the appropriateness of the resulting statements of task time. It is, however, meaningful to consider whether the measurements and statements have been made to the best level of refinement consistent with the variance in performance times. The variance referred to is that remaining after all feasible physical stabilizing measures have been taken. What is being said here is illustrated in the familiar fact that one of the most important purposes in establishing "standard conditions" is to reduce the variance in performance time. If it is not possible to standardize to the level of the element or of the cycle, then the variance at these levels will necessitate time statements based on larger units of production. The expected relationship might be stated generally as being a direct one between variance in task time and the size of the unit of production at which task time values start exhibiting stable parameters.

Notwithstanding all the controversy around the subject, it is true that if we observe human work in enough detail, multivalued performance time patterns emerge. This has been discussed with reference to repetitive work in publications, and the subject is introduced here simply as a reminder that variance is present in so-called highly repetitive work.

Since the statement of task time at any level of detail is of necessity based on an average, the only critical question on this parameter for the class of work under consideration is whether the average used as the best available results in an improvement in accuracy and usefulness of

the statement of task time. If, for example, a year's production were the smallest unit from which it was possible to draw a stable average, the accuracy of the task time statement might be improved over previously used estimates, but the period might be too long for useful control applications.

The approaches which have been used in determination of task time for the class of work under consideration may be classified into three types.

1. *The production study-standard data approach.* The nature of the activities and time values for these are determined in, generally, the same fashion as in a production study. Conditions variables[1] are reduced to tables or curves. The allowed or standard time is built up from constant time activities plus allocated or prorated time for conditions variable activities.

Usually there is no formal statistical analysis made of the time data. Specifically, parameters other than the average do not usually appear in analysis and computation of time values to be allowed.

Since variation of task time is characteristic of the class of work discussed here, it seems probable that failure to formally consider variance could be a serious defect in procedure in many instances.

This approach seems to have been the popular one for applications involving indirect factory work.

2. *Task time values evolved from work sampling of activities.* Examples of this approach have been reported by Sammet and Malcom (1) and by Wright (2), among others.

The general procedure involves noting, during an activity study, the number of units of production completed during a work spell corresponding to that which serves as the base for the activity study. If a day's work is the base, for example, the proportion of the activity, from analysis of work sampling data, is applied to total working time for the day to get daily minutes for the activity. This value when divided by units produced yields task time per unit.

The procedure indicates task times at the cost of a small amount of additional observing, and this is an advantage. On the other hand, data on the internal detail of statistical behavior of the individual task time values are not directly available. Again, because of the characteristic variation in task times, parameters other than an average may be important to the analysis.

3. *Direct sampling of task times.* This approach seems to have been little used and, except for studies of element and cycle time in repetitive work, little investigated. Yet, the procedure looks like a straightforward approach to the time problem in variable work. It could prove to be the preferred approach in some situations and the only feasible one in others.

For these reasons the approach will be discussed in more detail and an investigation will be reported in outline. First, it should be pointed out that "sampling" here does not refer to informal sampling procedures, but to sampling and analysis of data done under statistical procedures.

As ground work, consider a hypothesis which states that "the task times for observable human work will, at some size of unit of production, form frequency distributions which are mathematically manageable". The hypothesis is not original with this author. For example, Sylvester points out the possibility in his book (3). The implication of the hypothesis is that with respect to variable work the only practical question is whether the unit of production will prove to be small enough to provide a useful basis for improvement of planning and control.

The study outlined below was an investigation of the assumptions that:

1. The limiting conditions for measurement were only those stated earlier, i.e., (1) observable activity, and (2) economical sequence length of repetitious activities.
2. The hypothesis just stated is valid.

The State University of Iowa has a long term program of investigations of methodology for analysis of the less repetitive types of work. Some of the studies have been made of hospital nursing, among them the one to be reported here. This occupation seemed to lie pretty well out on the repetitive to nonrepetitive continuum and hence was a logical situs for such studies. As an industrial engineering investigation, it was necessary to consider the problem of measurement and prediction of task time. Among the numerous reports of "methods studies" in nursing we have not seen one in which this problem area was investigated.

Obviously the work situation is one in which a considerable number of variables may operate to affect the task times. It is also apparent that many of these variables are not subject to restriction at the direction of the industrial engineer—nor, in many cases, of any human.

The work studied has certain characteristics which may well be common to that of professional, technical, and administrative workers. Among these characteristics are:

1. The nature of the work is considered to necessitate freedom of individual determination of specific method for accomplishing an appreciable portion of the tasks.
2. Correspondingly, the required specific quality level of the "product" is determined by the worker for the various individual increments of product.
3. Access to, and consequently opportunity for standardization of, method and quality limit is severely restricted for the "outsider", i.e., the industrial engineer.
4. With both method and quality level "floating", considerable variation in task time occurs for the same kind of product ("same" being broadly defined).
5. Although the level is not specifically stated, quality of "product" is of prime importance—obtaining effectiveness of utilization of resources is a happy by-product or bonus, when obtainable.

[1] Short for: activities whose performance time will vary with the conditions encountered in a particular performance of the activity.

The investigation was carried out in one of the regular patient units ("wards") whose head nurse was willing for her unit to participate. In accordance with hospital policy all patients in the ward were of the same medical classification as to nature of illness. There was wide variation in specific kind of illness and severity of illness. The ward staff, of necessity, carried on its normal duties during the investigation. Almost all the patients were female, which meant that the engineer could not directly observe many of the activities. A nurse-observer was assigned to make the direct observations.

After general orientation of the staff to the investigation and of the investigators to the work situation, the problem was attacked as follows:

1. The morning, 7:30 AM to 12:00 N, work spell was selected because activity is greatest during this period.
2. Investigation of the process was made to determine:
   (a) what was to be accomplished
   (b) what activities or process steps were used
   (c) the sequential relationship of these steps
3. The process was questioned along the usual lines for process analysis.
4. With the staff intimately participating, steps were rearranged, combined, simplified. A standard written process was developed and installed.

The key to progress to this point was group recognition that much of the original variation was due to the variety of individual work plans for tasks which did not require exercise of professional judgment as to sequence or manner of performance. These were mostly the tasks done in preparation for those others which did require judgment as to manner of execution.

5. Each task was considered for the existence of inherent variability in required task time. Two tasks requiring relatively large unit times and a number requiring small unit times were identified as variable in time requirements. These latter occurred during the course of one or the other of the two major unit time consuming tasks.
6. Unit times for constant tasks were determined by simple average of a group of nonrandom observations.
7. Time for conditions variable tasks were observed by random sampling of individual performances. Means and variances were computed. The group of small unit time tasks were allocated to one or the other of the two larger tasks, during which they occurred as interruptions or departures from the definition of the latter task. The time to be so allocated was the sum of the products of mean unit time by expected frequency of occurrence.
8. A second data run on the two large variable tasks was made 28 days after the beginning of the first run. Table 1 is a summary of the results of the two data periods and of test for a common underlying universe of task times. Applicability of normal distribution procedure was decided from inspection of the frequency arrays.
9. The data of the two periods were combined, new means and variances computed, and these means added to those for constant tasks to serve as a predictor of daily elapsed time for the team group of tasks.

TABLE 1

Summary of Difference of Means Analysis

Activity	1st Period Dec. 8-18, 1953				2nd Period Jan. 5-27, 1954				$\bar{x}_1 - \bar{x}_2$
	N	X	S	x	N	X	S	x	$\bar{x}_{1-2}$
Bath and backrub	38	6.16	2.40	0.39	145	6.27	3.04	0.25	0.23
Bedmaking and clean	44	8.1	3.5	0.53	83	7.89	3.17	0.35	0.33

The predictor for required staff differed only in that one standard deviation each of the two major variable tasks was allowed. This was done on the grounds that staff size should allow for the occurrence of greater than average severity of patients' condition and that those two time distributions were the only ones reflecting differences in the patients' conditions.

10. Certain constant time activities not received by all patients were prorated on average experience basis and a predictor chart was prepared for the head nurse. This chart is shown in Figure 1. Two curves

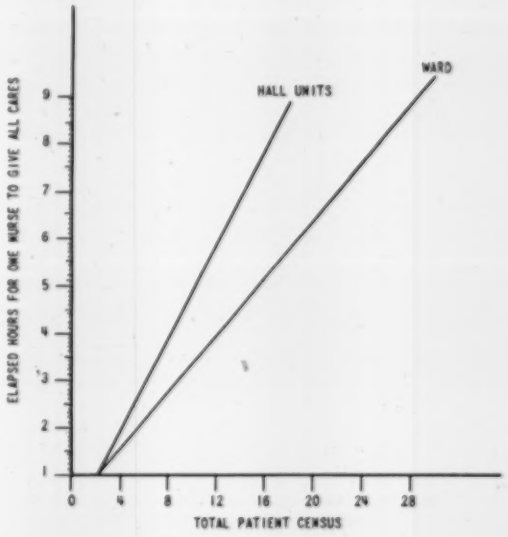

FIG. 1. Head Nurse's chart for predicting elapsed time for morning care (daily control). Scales reduced to one-half of original.

are needed because some task times differ, depending on whether the patients are in open ward or in hall room accommodations. The value on the ordinate is the elapsed hours predicted if one person performs all activities. The head nurse reads this value for the ward and also for the hall rooms against number of patients in each type of accommodation. The two readings are totaled and divided by man hours of staff available per hour. The result is the predicted elapsed time for the team performing the group of activities.

It should be noted that no access to internal method of performance of patient's condition variable tasks was allowable for the engineer, and this situation had to be accepted as a part of the problem of developing a measuring and predicting procedure.

Performance of the prediction procedure is shown for daily control in Table 2. The criterion for useful accuracy of prediction was established by the head nurse, well in advance of development of the predictor, as an error of 15 minutes in a total elapsed time as small as 150 minutes or as great as 240 minutes. The omitted dates are those on which the head nurse was not on duty. In order to avoid biasing the results the head nurse was asked to personally compute the predicted elapsed time at the beginning of each day and not to reveal the attempt at prediction nor the answer to the staff. The computation took her about 5 minutes. The last staff member to complete the duties reported the actual completion time and, hence, established the actual elapsed time. Table 2 shows errors in prediction of the actual elapsed time. A minus sign means that the actual was less than predicted by the indicated amount.

With respect to staffing predictions, at the close of the study the unit had been operating for over 50 days at the predicted level. This was one person less than the head nurse's initial estimate of minimum staff. The head nurse, the nursing supervisor of the service, and the medical chief of service all rated the quality of patient care as satisfactory.

TABLE 2

Variation from Predicted Finish Time, Average Patients' Conditions

Date	Minutes Variation from Predicted Finish Time
June 2	7
3	13
4	−1
7	−4
8	−10
9	15
10	−8
11	12
15	8
16	4
17	−12
18	−4

Economy of the procedure. The investigation was experimental and so involved a lot of observing, analysis, and computing. However, had the daily control been based on data of the first data period only, the predicted elapsed time for full patient load and predicted staff would have been overstated by 1.68 minutes out of 240. The indication from this is that the restriction of a single source of variation may permit development of a dependable predictor from a relatively small sample size. In this case the restricted source of variation was the multiplicity of individual work plans, and when this was restricted a sample of approximately 50 would have been the economical size.

Check studies in other wards where no serious attempt was made to restrict multiplicity of work plans resulted in the conclusion that it was not feasible to develop a practicable predictor for daily control. For example, analysis of a much larger body of data indicated the existence of not less than eight separate task time distributions as counterparts of the two major time tasks in the study just outlined.

The investigation just reported may be summarized as a demonstration of a feasible approach to formal planning and subsequent measurement of work performed by professional level workers and assistants. The work itself, while obviously subject to many variables as to task time requirements, was not completely variable nor so between unpredictable limits. The restriction of sources of variation which are existent but not inherent to the work is an important condition to the subsequent measurement, prediction, and control problem. Deliberate and direct sampling of task times, resorted to as the only apparently possible expedient, produced satisfactory results. The two assumptions of the investigation were supported by the results.

It is concluded from the study that the third approach, just illustrated, may provide an approach to situations previously considered to be too variable for handling. Certainly this approach seems worthy of more investigation by industrial engineers. We at Iowa intend to investigate it further.

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The Engineer and the Corporate Team*

By E. Finley Carter

Manager of Research Operations, Stanford Research Institute

The role of the Engineer is becoming increasingly important in the complex we call modern industry. Just an attempt to classify the skills essential for its operation is enlightening. We have industrial engineering, management engineering, methods engineering, time study engineering, administrative engineering, data-processing engineering, electrical engineering, mechanical engineering, chemical engineering, civil engineering, electronic engineering, hydraulic engineering, aerodynamics engineering, microwave engineering, production engineering, machine design engineering, automotive engineering, quality control engineering, and we could go on and on naming them. No wonder there is a shortage of men with specialized training in so many branches of the profession.

Logic and analysis, so much a part of the training of an engineer, together with the ingenuity and resourcefulness expected of one choosing engineering as a profession, are all valuable assets. They become even more so when they are properly integrated along with technical knowledge and skill into the corporate team. It is this process of integration and the individual engineer's role in its accomplishment that I want to discuss.

Most of what I shall have to say, upon analysis, is so logical that it should be obvious. However, as engineers, we are often accused of making simple things complex, as well as vice versa; and I fear this is often true with our human relations.

Whatever we might choose as a social group or team, there are in addition to skills two ingredients of paramount importance. One is mutual interest, which we can consider as a motivating force, and the other is mutual confidence or respect. If there is a mutuality of interest between producer and consumer, there is a potential business. If it exists between stockholders, management, and employees, there is the incentive for a corporate organization, and, if all those who are the members of the corporate team have a common goal, there is good reason to expect a successful operation to result. Unfortunately, mutual interest alone is not enough. The mutuality of that interest must be recognized and there must be the ability to do something about it through the pooling of the knowledge and skills required. However, real success is assured only when there exists mutual confidence vis-a-vis, the individuals making up the team.

Now, how may this be achieved? I am sure not all that I shall have to say is peculiar to the engineer, but I am talking to an audience of engineers and am convinced that an attempt on the part of each of you to recognize your own potential in the development of a wholesome working environment will pay dividends.

First, you must have confidence in yourself. There is a no more insidious deterrent to mutual confidence than an unrecognized lack of self-confidence. One's ego attempts to compensate for inward insecurity by helping him to see his own worst faults and many more in his associates rather than in himself. If, without recognizing this little trick, he bolsters his false pride by dwelling upon the faults and mistakes of others, there is a compounding of his own insecurity and an impairment of that for the team of which he should be a part.

Strengthen your own self-confidence by focusing your attention upon the best within yourself and within others. Back up your sincere convictions with courage and enlist the help of others in constructive effort. Nothing succeeds like success and a modest contribution can bolster one's self-confidence more than a masterpiece in wrecking somebody else's reputation.

Now, let me urge a word of caution on the other side. Others too have pride and their egos are seeking to protect them. Do not unwittingly make it more difficult for those around you. I have seen too many instances where engineering and production personnel have not only found difficulty cooperating but in some instances have actually become antagonistic toward one another. The most common cause and correction for this might well be gleaned from a little story. A well-dressed lady is often as fastidious about selecting a slip or petticoat as she is the dress that covers it and yet, have you ever noticed just before going out to a party how careful she is in checking to make sure that her slip is not showing? Then at just the right time, while seated in a group, she will deftly cross her legs allowing just enough of her pretty petticoat to show to enhance her overall attractiveness. My advice to you is, "Don't let your education show except in an audience where it becomes you and, even then, show it sparingly". You will note I said *show* it sparingly—not *use* it sparingly!

We Americans put a lot of emphasis upon freedom, and rightly so, for it is our heritage—it is the heritage of every fellow on the team. It is not a random or purposeless freedom that we respect but a freedom of choice. If you

* Based on a presentation to the Peninsula Chapter of AIIE, May 10, 1955.

will remember this, you will realize that in essence everything you get through an individual comes through his will. Even when he is frightened or bullied into performing his act, he is choosing between doing what he does and some more unpalatable thing. If he has his heart in his work and gives with enthusiasm, his action is regenerative. If his choice is always a reluctant one, the effect will be degenerative. Real authority is born of respect; it is never more effective than when response to it reflects the warm and sincere respect of the respondent.

Such respect is gained not just from knowledge and experience one has but from the way he uses them. It is a product of knowledge, experience, and understanding, and there is no field—not even that of engineering—in which understanding plays a more important role than in human relations.

To you who are Industrial Engineers, I am sure, this is not a new thought, but you, like all of us, can afford to heed the warning that our emotional natures do not readily permit the same degree of objectivity in dealing with personal problems as we have been trained to use in studying the inanimate. You have to make a more conscious effort to understand why you react as you do to the action of your associates and vice versa. This conscious effort is enhanced and implemented by more effective communication between those concerned. Each of you can take the initiative in improving such communications. Before closing I would like to suggest two important channels through which that communication may be improved for the good of all.

First, each individual has something to give as well as something to gain from all others who make up his particular group or team. A genuine interest in each of his associates and in his associates' work begets a reciprocal attitude which is the basic ingredient of mutual trust and cooperation. An exchange of ideas in such an atmosphere enriches each participant. Through the stimulation of thought such an exchange is often responsible for a prolific conception of many more ideas. One does not lose his own individuality in helping others to feel that they, too, are playing vital roles. Instead, he is thereby perfecting the real art of communication and is at the same time winning allies.

A second communication channel is to and through the management of one's employing organization or corporation. Even though great opportunities are open in top management for engineers with vision and broad interests, management needs technical guidance from all levels of an engineering organization. The technical complexity of our industries today requires the cooperative effort of men who have attained competence in their respective specialties. Such effort properly coordinated eventually results in tangible products, the production and distribution of which are essential for the continuation of progress. In order that this cycle may be successfully completed, it must first get under way. Management is responsive to those whose competence and faith say a thing can be done, and whose determination says it will be done. It is not difficult to sell when conviction and enthusiasm are present. For our own good and for the benefit of management, let's play on management's team. It will surprise many who have felt that management's function is to hold tightly the purse strings and oppose engineering expenditures to learn what an excellent ally management can be when its confidence has been won. This communication channel through management to and from the ultimate consumer is essential to our very existence.

I know of no more fitting authority to quote in closing than King Solomon himself who, in Proverbs, says: "Wisdom is the principal thing, therefore, get wisdom, and with all thy getting, get understanding".

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A Hyper-Audio Pulse Triggered Input Device, for Work Measurements, Standard Data Sampling, and Biological Response Studies

By Christian Rand, B.Sc., M. Sc.

University of California, Los Angeles

The measurement, or timing, of human motions and reactions is an important phase of most all research within such fields as psychological reaction studies and work measurement investigations. Within the applied field, motion and time studies have been carried out with rather crude instrumentation, such as the decimal stop watch. For laboratory purposes, however, where trends and patterns are sought, much more accurate time determinations than those yielded by stopwatches are required.

As early as the turn of the century, F. W. Taylor (1) pointed out the possibility of collecting and tabulating common work elements, and later used these for synthetical time studies. A further step in this direction was made by the Gilbreths (2) through their development of the micromotion technique and their classification of the work elements ("therbligs"). Since that time, a large number of studies involving timing of the human work elements have been carried out through the use of micromotion analysis. However, the demand for higher accuracy, along with the trend toward larger sample sizes of observations, has created a situation where micromotion analysis becomes expensive and very time consuming at best. It is an inherent drawback of the technique, that either accuracy or sample size must be sacrificed if micromotion analysis is to be used without complete disregard to cost.

This drawback has long been recognized, and during the more recent years, several other forms of instrumentation systems have been developed whereby timing of the human activities can be carried out. Such instrumentation systems have ranged from simple hand-activated mechanical recorders, to relatively complex electro-mechanical systems capable of displaying their results as statistical distributions. An example of such an instrumentation system is the Kymograph, developed by R. M. Barnes. (3) Recently, all-electronic recorders, or counters, were proposed as elements of such instrumentation systems by, among others, A. J. Rowe. (4)

In contrast to the micromotion technique, electromechanical and electronic instrumentation systems require some form of input device capable of detecting the beginning and the end of the work elements being studied. Photoelectric relays, microswitches, and fingertip-material contacts have become typical input transducers for such applications.

It is an unfortunate characteristic of the development so far, that there has been too little cross-breeding between the work measurement scientist and the instrumentation engineer. This has caused a large degree of mismatch between the instrumentation system elements. This mismatch, particularly apparent in the selection and use of input transducers, stems from the following:

1. The work measurement scientist is very often unfamiliar with the transfer characteristic of the input devices used, and equally unfamiliar with the large number of new transducers developed during the last years.
2. Most instrumentation engineers are not sufficiently "motionminded", and hence not capable of understanding the particular transducer characteristics required for work measurements.
3. So far, almost all attempts have been to "fit" the input devices to locations where the traditional "therblig" breakpoints are expected, rather than to redefine the work elements to fit the input device selected.

Recent studies on the accuracy of various work measurement transducers carried out by the author (5) has revealed several sources of considerable time lag and inconsistency within almost all presently used input devices. During these studies it was also found that attempts to improve the transfer functions of the various input devices, more often than not, resulted in greatly increased complexity, inflexibility, and cost.

With the above outlined state of affairs in mind, it was decided that a completely new approach was needed, an approach that could secure accurate and reliable time determinations within the fields of biological time response and work measurement, not only for the presently used instrumentation systems, but even more so for the benefit of the all-electronic instrumentation systems that are bound to come in the near future. A continuation along the present philosophy, where improvements are made only on already known systems and transducers, will most

likely produce only prohibitively expensive equipment, still unable to match the inherent high response properties of the future all-electronic recording facilities.

The Problem

The problem can be broken down into two basic categories:

1. What is the nature of the motions (or response) to be measured, and what is the required degree of accuracy of the measurement.
2. How is the motion to be measured, and what accuracy is obtained.

In biological research, the time interval normally represents the elapsed time between some form of a stimulus, and some form of motive response. In work measurement, the time intervals of interest are normally those of the work elements, referred to as "therbligs". Always involving some displacement of body members or muscles, such time intervals must have a finite value. Elsewhere (5) it has been indicated that time intervals of an order of magnitude less than $\frac{1}{100}$ sec. are not to be expected in any human motion. Thus, if time measurement can be made with a reliable accuracy equal to or better than $\frac{1}{10,000}$ sec., the error in time determination will be so small (less than 1%) that it can be discounted when compared to any time interval measured. Hence, to assure results where the measurement error always is of a negligible order of magnitude, it seems logical to plan for instrumentation systems where measurements can be carried out to within 10^{-4} sec. or better.

The measurement system itself can be broken down into two parts:

1. The recorder or counter with associated equipment.
2. The input devices, or transducers used.

Since both these sections of the system will be determining factors in the overall measurement accuracy, the least accurate section will govern the end results. Although present day electro-mechanical recorders have characteristics preventing accuracies much above $\frac{1}{500}$ of a sec., present all-electronic recording systems can provide time measurements to an accuracy way beyond the required 10^{-4} sec. The recorders can hence, with the exception of cost, be eliminated as being a problem. Thus, it remains to find or develop a transducer, or transducers, capable of yielding the desired order of accuracy.

The Transducer

Before any attempts are made to introduce new transducers, some of the desirable properties of such transducers should be summarized:

1. The transducer should have a time response equal to, or better than, $\frac{1}{10,000}$ sec.
2. The transducer should be able to accurately detect breakpoints in the motions or work cycles. Such breakpoints do not, however, necessarily have to coincide with the traditional "therbligs", as long as the sum of the detected element times adds up to the cycle time.
3. The transducer should have a high operational flexibility, so as to facilitate easy experimental set-up as well as changes during the course of experimentation.
4. The transducer should in no way limit the motion freedom of the operator, nor should it possess any characteristics that might cause psychological effects, biasing the operator attitude, or performance.
5. The transducer should, as far as possible, be a general one. That is, it should be possible to apply the *same* type transducer to a large number of various instrumentation situations. Equally, the transducer should be able to activate all present and future instrumentation systems.
6. Last, but not least, the transducer should be relatively inexpensive, and require a minimum of auxiliary equipment.

Keeping these desirable requirements in mind, an analysis of various transducers presently being used will indicate that none of these possess the desired characteristics. (5) The most promising system seems to be the material-fingertip contact. That is, the system where wires along the arms of the operator, out to the fingertips, close instrumentation circuits when the fingertips touch material, material-bins, or assembly jigs. This system provides excellent breakpoints for the elements, and studies reveal that the system basically has a very favorable response characteristic.

Although this principle is hampered by several serious fundamental defects, such as limited motion freedom, psychological bias effects, etc., the basic response and simplicity made it a logical choice for attempted improvements.

Two major drawbacks, and one minor one, needed attention in order to develop a fingertip-material-contact system, fullfilling the above stated requirements.

First, the wires along the body members of the operator had to be eliminated, since it is virtually impossible to apply such wires to a human being without causing discomfort and restrained movements, as well as psychological bias effects on all but, perhaps, technical personnel.

Secondly, since the system only works with conducting materials, the detection current had to be made zero, or extremely small, so as to eliminate the high resistance of graphite coated nonmetallic parts from the system parameters.

The new system is shown in Figure 1. This diagram serves a twofold purpose. Above all, it is shown to indicate the nature of the equipment involved, and the fundamental principle of operation. Secondly, the diagram as indicated represents a practical, useful transducer circuit, applicable to almost all simple and complex biological response studies, as well as to *some* of the work measurement elements.

The principle of operation is based upon two electronic circuits:

1. The pulse generator.
2. The pulse detector with its associated gating circuits.

The pulse generator, a hyper-audio (or sub-r.f.) blocking oscillator, generates a high frequency voltage that by

capacitive coupling is induced into the body of the operator being tested. The hyper-audio frequency selected (100 Kc/s.) along with the very low power output 10.1 W. causes this triggering signal to be way below the threshold of all human senses. The capacitive coupling to the human body can be applied through a concealed antenna, built into the seat or the back of the chair, in which the operator is seated. If the pulse oscillator is transistorized, the operator can carry the oscillator in a pocket. In this manner, both motion limiting and psychological effects are eliminated.

The pulse detector, attached to the jig, material bin, or circuit desired triggered, consists of an amplifier tube, triggering an Eccles-Jordan bistable multivibrator. Touching the input lead to the amplifier will cause the *first* positive pulse transmitted through the body of the operator to drive the amplifier grid from its normal, "beyond cut-off" level, into a conducting region. When this occurs, the bistable multivibrator will change state, provided the multivibrator half section, associated with the input amplifier, is in its nonconducting state. Subsequent pulses transmitted to the amplifier input *after* switching has occurred will *not* affect the circuit, due to the low amplifier plate voltage, and the grid clamping diode preventing the grid from going positive. Thus, switching will occur within one cycle of the oscillator frequency after the body member has touched the input. The selection of carrier frequency should be made intelligently. The frequency should be high enough to secure the required time response as well as good coupling between the oscillatory source and the body, yet low enough to prevent r.f. coupling between the fingertips and the pick-ups. Frequencies between 10,000 cps. and 100,000 cps. have been found to yield very satisfactory results.

Since the amplifier tube will start to conduct current while the grid is still negative, no current other than those caused by eddy and stray losses will be required to operate the detector. Hence even poor conductors, such as graphite coated or aluminum painted parts, can be used.

In addition to the circuits already described, the complete input device as outlined in Figure 1, contains an electronic gating circuit for operation of electronic recorders, as well as an electromagnetic relay gate for operation of electromechanical recorders. The electronic cathode follower gate has no effect on the system time response. It should be stressed, however, that the introduction of an electromagnetic relay will *reduce* the system response properties to those of the particular relay selected. A good high speed relay, with a response of 1 to 4 msec. should be able to match the transfer characteristics of almost all electromechanical recorders. The only auxiliary equipment needed to operate this input device, is a standard laboratory power supply, yielding 300 v. plate voltage, −75 V. bias voltage, and 6.3 V. A.C. for the tube filaments.

In biological response studies, response time data can be obtained by, for example, randomly operating the "RESET" switch to activate the right hand "STATE INDICATOR" neon light. The task of the test object will be to touch the input

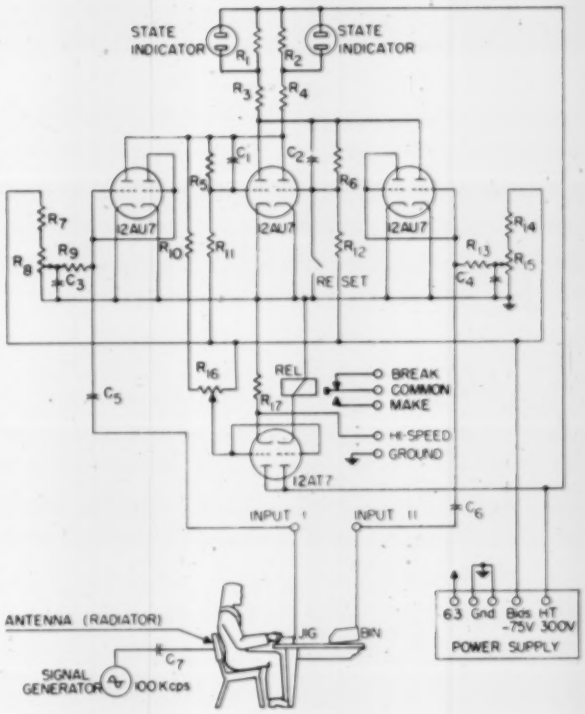

FIG. 1. Hyper-Audio Pulse Triggering Input Device for Work Measurement Recorders.

terminal as soon as he sees the light go on (simple response study). The response time, that is the time interval between stimuli and response, can be recorded on an electronic time interval counter, being activated by the "HI-SPEED" cathode follower gate. In such a study, the instrumentation delay error can be completely discounted.

The input device, as indicated in Figure 1, is *not* capable of detecting all work elements. As shown, only elements such as "grasp + transport loaded" or "assembly + transport empty" can be measured. If a material bin, containing metal washers is connected to "INPUT II" and an assembly jig (a metal bolt) is connected to "INPUT I" the input device will switch "ON" when the fingers touch the metal washer in the bin (beginning "grasp") and "OFF" when the transported washer touches the assembly jig (end transport loaded). For such time measurements, as was the case with the response measurement described above, the internal transducer lag can be discounted.

As stated in the introduction, a slight redefinition of the work elements, from those defined by Gilbreth for micromotion-analysis, will make it possible to use the basic principle outlined in this paper for further breakdowns of work elements. Besides the redefinition, such instrumentation will require a slightly more complex circuit, involving more input detectors and some electronic logic.

Say that the work element "grasp" is defined as being the time between the first contact of fingers and selected

part, and the moment the part breaks contact with the bin. If a monostable (freerunning) multivibrator is now connected to the material bin, the pulses transmitted by the operator will keep this multivibrator in action from the first contact until the part breaks connection with the bin. Along the same patterns most all other work elements can be redefined and electronically instrumented. The work of defining the "electronic therblig's" and designing the associated electronic transducers, is not yet completed. However, no fundamental hindrance can be visualized at the present state of development.

Conclusions

1. The hyper-audio pulse triggered input device, described in this paper, offers unique possibilities of performing highly accurate time measurements within the fields of biological response studies and work measurement investigations. Time measurement to an accuracy of $\frac{1}{10,000}$ sec. or better can easily be secured, provided all-electronic recorders are used along with the proposed transducers.

2. The system described eliminates all previously present maleffects such as limited motion freedom and psychological bias, since no visual connections between the instrumentation and the operator are required. The r.f. signal, replacing the wires, is of a frequency and power level well below the threshold of all human senses.

3. In biological studies, as well as in work measurement studies, the system possesses a high degree of operational flexibility, since only one wire is required between each input and the electronic circuits. Thus the "pick-up" location can be changed without any readjustment being required.

4. Although only briefly mentioned in this paper, the use of the system described offers an opportunity to redefine the work measurement elements in a more accurately determinate manner than the traditionally used micromotion "therbligs", thus assisting the design of better and more accurate Standard Data systems.

5. The system described works equally as well with conventional electromechanical recorders as with the more advanced electronic recorders.

6. Considering the high degree of accuracy as well as the high operational flexibility, the system can compete with any presently known transducer system, economywise.

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List of Component Values, Fig. 1

R 1	47 K. ohm 1 W
R 2	47 K. ohm 1 W
R 3	56 K. ohm 1 W
R 4	56 K. ohm 1 W
R 5	240 K. ohm $\frac{1}{2}$ W
R 6	240 K. ohm $\frac{1}{2}$ W
R 7	200 K. ohm 1 W
R 8	100 K. ohm potentiometer
R 9	5 megohm $\frac{1}{2}$ W
R 10	1 megohm 1 W
R 11	200 K.ohm $\frac{1}{2}$ W
R 12	200 K. ohm $\frac{1}{2}$ W
R 13	5 megohm $\frac{1}{2}$ W
R 14	200 K. ohm 1 W
R 15	100 K. ohm potentiometer
R 16	1 megohm potentiometer
R 17	15 K. ohm 1 W
C 1	100 mmF. 600 V
C 2	100 mmF. 600 V
C 3	.25 mF. 200 V
C 4	.25 mF. 200 V.
C 5	750 mmF. 600 V
C 6	750 mmF. 600 V
C 7	750 mmF. 600 V
State indicator	60/75 V neon glow tube
Reset	Push button
Rel	High speed relay (see text.)
Signal generator	See text
Power supply	300 V plate supply at 30 mA; −75 V bias supply at less than 1 mA; 6.3 V Heater supply at 1.2 A

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Microcosm

By D. H. Denholm

Chief Industrial Engineer, Chase Bag Company, St. Louis, Missouri

One of the delightful enigmas an industrial engineer faces is being in a position of knowing what to do (always); and knowing what is being done (sometimes) and not being able to bring them together (constantly).

Have heard some folks say it is a most frustrating experience. We are not always in a position to solicit immediate management support, complete Union approval —we even have trouble with agreement among ourselves.

Those of you who by-pass this enigmatic condition are indeed fortunate. Most of us struggle our way step-by-step, fighting problems that have no academic reason for existence.

Because of these constant conflicts we would like to offer a story without a moral. We hope the more gifted in our ranks can absorb—osmosis-like—some stimulation which will guide their future actions.

The story we have to tell is one of conflict in wage incentive administration. Under no circumstances is this to be considered a condemnation of the practice of paying incentive. On the contrary, the writer is an enthusiastic supporter of incentives. It has been our fortune to spend our entire working life developing and administrating such plans.

In this experience, we have become an enthusiastic supporter of incentives as the "magic bullet" or catalyst which will keep and guarantee the American Way of Life. When incentives are designed and administered properly they will, in every instance, result in increased production. This production has two inherent corollaries; (a) lower production costs making for a stronger and healthier competitive manufacturing organization and (b) the opportunity for increased hourly earnings by the worker as a reward for the contribution of effort and skill (and in many cases, as a reward for contributing to "pre-planning").

Nowhere can the writer find another single tool which can accomplish this "miracle" of the American way of life . . . increased productivity, lowered cost, higher hourly earnings and ultimate lower cost to the consumer.

How can we have this out of the muddle that we sometimes precipitate? The answer must be that there is no placebo which is pleasant in taking and yet totally effective. The results can be achieved only by hard work, a basic understanding of the rights of human beings, the application of scientific industrial engineering principles, and a constant consuming desire to make these work.

We have made a hobby of collecting case histories illustrating conflict under incentive administration. Without further philosophizing, let me present to you a story concerning quality, piece work and human beings. We can make no moral of this . . . draw your own conclusions.

On the last of June, 1950, Harry Brinks threw down his casting. The foreman had just handed him his pay check and he noticed that it listed a deduction for defective castings.

The following work day, he got his fellow members together and they all agreed that deductions from their pay for scrap was totally unfair. Subsequently, he and his friends found the shop steward and persuaded him to issue a grievance which read as follows:

"We object to the present scrap plan in the foundry. We request the plan be discontinued and molders be paid for chargebacks beginning July 1, 1950."

Had we been a participant in this case, we would have known that the foundry scrap plan was in effect since October 20, 1947. Under it, when the percentage of metal returned to the cupola for remelting is less than 30% of the gross melt, no deductions are made from the incentive earnings of foundry personnel for defective castings. When the remelt is over 30%, deductions are made in accordance with a schedule listing responsibility for different types of defects in castings and a schedule of labor value attributed to different castings.

During the preceding week of the grievance issuance, the remelt exceeded 30%. The total deductions from all of the foundry personnel for defective castings was $9.93. A month prior to that the deductions totaled $27.84 and two months prior to that the total deductions totaled $19.78.

Daily the defective castings are sorted and lined up on a bench by the inspector who lists them on a form according to the type of defect and posts the report. The foreman classifies the castings for which he considers the molders to be responsible. Employees then have an opportunity to observe the scrap and discuss their alleged responsibility with the foreman. If they so choose, the matter can be taken up as a grievance if they feel that the foreman does not receive their explanation sympathetically.

In subsequent meetings, the union agreed that the contract phrase describing the molders piece work plan contemplates payments only for acceptable work. It does not challenge the right of the company, therefore, to

charge back scrap attributable to the worker, but it does not accept the plan whereby the foreman solely determines responsibility. It contends that the company must prove beyond a reasonable doubt that the fault is due the operator. Further, the contract does not mention the molders plan, and therefore is open to a grievance and subsequent arbitration.

The company insisted that payment for good piece work only is a consistent plant-wide policy authorized by the contract, even though there are variations in the form in different departments.

It might be interesting for us now to pause and to read the portions of the contract concerning the direct incentive.

"The present standard hour plan is used for direct incentives, which provides an opportunity for additional earnings over and above the occupational step rates for those jobs where both the work content and output can be accurately and economically measured and recorded."

"The quantity of quality work to be performed under specified conditions by an employee in one clock hour to earn his occupational step rate is called a standard hour. This standard hour is expressed in pieces per hour. From this figure is derived the decimal hours per piece which is known as a production standard.

"This contract expresses the entire agreement between the parties hereto and it is mutually agreed that neither party, during the term of this contract, shall have the right to require the other to enter into negotiations or to entertain demands on any subject whether or not expressly referred to in this contract, except wages and insurance as expressly permitted in this contract and except alleged violations of the express provisions of the contract."

Subsequent meetings were to no avail and, consequently, the factors—much as mentioned above—were brought to arbitration. The arbitrator eventually ruled that the union's theory—"Since this foundry's scrap plan is not mentioned in the contract it is therefore not valid"—is ruled out. The arbitrator's wording was interesting. He states, "Collective labor agreements are not in nor not negotiated in a vacuum but in a setting of past practices and prior agreements".

He further stated the evidence that the union presented challenging the propriety of the schedule of responsibility of bad moldings might well be so. It was his feeling that this would perhaps be an appropriate subject for consideration in determining a grievance wherein a molder claimed to be wrongly charged with responsibility for defective castings. No such grievance had ever been filed.

The arbitrator finally and wisely indicated that where a plan has been in operation for a considerable time, a party challenging it has the burden of proving that it does not conform to contractual requirements or that its operation has caused erroneous results. In this case, the union has not established either proposition.

Subsequently, the award was given the company and the scrap deduction plan was continued. During the course of the grievance and arbitration, the molders were paid their past average piece work payment.

Harry did not like this at all, but agreed to go back to work since they felt from the very beginning that the deductions, as can be seen, were quite modest. They resolved to see that the foreman would have a more difficult time in determining responsibility for bad moldings.

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2. **Linear Responsibility Charting**—Mr. SERGE A. BIRN, *Management Consultant and President*, THE SERGE A. BIRN COMPANY, Louisville, Kentucky
3. **Teaming Up On Automation**—Mr. R. A. McCARROLL, *Mgr. of Industrial Engineering*, PLYMOUTH DIV. OF CHRYSLER CORPORATION, Highland Park, Michigan
4. **The MTM-Time Study Team in the Office**—Mr. JIM THOMPSON, *Mgt. Consultant*, U. S. STEEL CORPORATION, Pittsburgh, Pennsylvania
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Engineering on Wheels—C. D. ALLEN, *Member, San Francisco Bay Area Rapid Transit Commission*, San Francisco, California

Square Pegs in Square Holes—DAN FOSTER, *Manager, Employment Dept.*, LENKURT ELECTRIC CO., San Carlos, California

A Study of the Accuracy of Measuring Time Study Elements with Visual Break Points

By Nasri D. Magar

Department of Engineering, University of California

The basic problem considered in this study is the investigation of the variability with which time-study observers read visual break points, that is, specifically to:

1. Determine whether intra or inter-individual differences contribute most to over-all variability in reading the stop watch.

2. See if variability is a function of experience, company and element length.

Importance of the problem. The number of watch readings required to secure an adequate mean element time is a controversial part of everyday time-study procedure used by industrial plants. Some time-study people select a "best" value by inspection, others rely on large numbers of observations to produce a stable mean for each element. A recent tendency has been to base the number of observations needed on the variability of individual observations. Experimenters using this last technique have recognized that variability of individual observations contains two elements:

1. Variability of the measured process, i.e., the worker.

2. Variability of measurement, i.e., the time-study man's reading of the stop watch.

With this in mind, the operator used in this study was selected in order to minimize the variability due to the worker's performance. Few companies try, in a similar fashion, to reduce the variability of measurement by selecting properly their time-study men.

If the variability of the time study is decreased, the number of observations can be reduced—which will prove to be economical. Such reductions can be obtained by:

1. Selecting time-study men if inter-individual differences exist.

2. Training men to read the stop watch better if intra-individual differences contribute most to variability of watch reading.

This study will seek answers to several other questions, such as:

1. How effective is experience in reducing variability?

2. Does the operating environment of different companies, for experienced time-study men, also make a difference?

Factors Involved in the Problem

In general, time-study writers believe that the more minute the measurement, the more useful is the result. The fact is that the scientific value of measurements does not depend upon their minuteness. It depends instead upon their accuracy and precision. Most time-study writers recommended .05 to .10 as the best length for time-study elements. Therefore, in this study three elements of .04, .09 and .10 minutes length have been used, all with visual break points.

A simple assembly cycle was used to simulate a factory situation in generating break points at which the watch is read. Micro-switches actuated recording pens on an Esterline Angus Kymograph type time recorder which produced the more precise and accurate element times—called "true" time.

In accordance with the experimental design, the following equipment was selected and can be divided into two categories:

1. Testing Equipment (Figure 1).
   a. Testing of an assembly which is the battery-lug.
   b. Work place arrangement.
   c. Time-study stop watches.

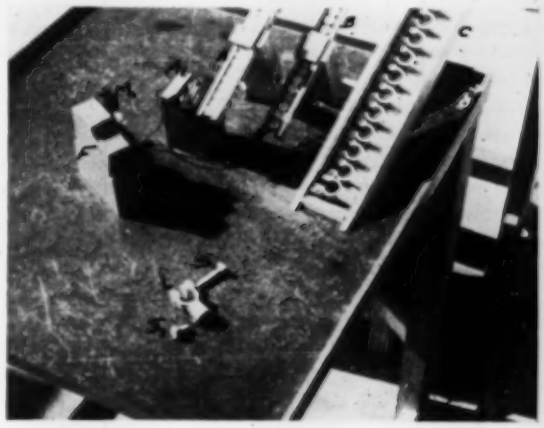

FIG. 1. Testing equipment

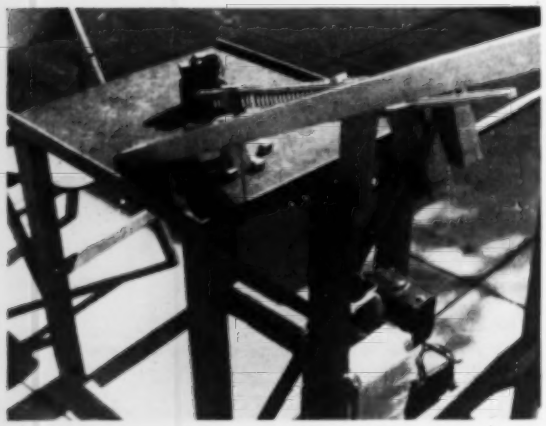

FIG. 2. An Esterline Angus Recording Kymograph

2. Time Recording Equipment: An Esterline Angus Recording Kymograph (Figure 2).

In order to secure visual break points and at the same time record the element times by the Kymograph, a fixture (F) was built to keep the body steady when engaging the screws to the lug and for holding a micro-switch in a fixed position. The lug wire hole slid over a one-half inch (outer diameter) short pipe (P) at the horizontal edge of the fixture, to keep the lug in the correct position. At the edge, a micro-switch (M_1) was fixed such that the body (battery lug) interrupted the switch when positioned or disengaged from the fixture. The gravity feed chutes (A, B and C) were built for the three parts of the lug (A for the long screw, B for the short one and C for the body). Another switch (M_2) was placed at the (released) end of the long screw chute.

The operation consisted of the following elements:

Element I. Remove and put aside assembly in tote pan and place a lug in fixture.

Element II. Get and assemble small screw and release long screw.

Element III. Assemble long screw.

The representative time-study groups were the following:

1. *Undergraduate group with no experience.* This group represented time-study observers having a good knowledge and very little (school laboratory only) experience in time-study and motion economy.

2. *Graduate group.* This group consisted of students in an Industrial Engineering graduate time-study class at the University of Southern California.

3. *Company group.* This group was composed of time-study men, of one firm, with different periods of experience.

The object of the experiment, together with instructions, were given to each group. The sequence of the elements previously outlined was clearly identified to the men. Questions raised by the subjects were very clearly explained. Then one or two trial runs (30 cycles per run) were timed, until the men were acquainted with the cycle and its elements so that no one cycle or even an element would be missed and also to overcome the learning effect. Finally, the time-study men timed the formal run, beginning with the second cycle, to overcome any confusion and to effect complete concentration on the study.

Analysis of Data

Errors in watch reading. Watch reading is the key point of this study, i.e., the study was made to find how accurate and precise time-study men are in reading their watches. Watch reading errors may be made by a given man or between men. This will be discovered in the statistical analysis of data, as well as the effect of experience and element time length upon watch reading.

Statistical tests used. Karl Pearson's chi-square test was the chief statistical technique used to test hypotheses concerning the distribution of deviations or errors from one person to another.

Since it was possible that the variability could be influenced by differences in training, three groups (Undergraduate, Graduate and Company) were used, and each group was subdivided according to experience. The subgroups were the following:

1. No experience.
2. 3–18 months (inclusive) experience.
3. 18 months to 3 years (inclusive) experience.
4. Over three years experience.

To determine the significance of inter-individual differences within experience subgroups of each group, the hypothesis that the distribution of watch-reading-deviations was the same for all people in the subgroup was tested by chi-square for each element and each subgroup.

The statistical analysis showed that there is a difference among the distributions of watch reading errors among individuals in the Undergraduate group for all elements except Element III.

Since inter-individual differences within an experience subgroup were significant, only in the case of Element I for the Graduate and Company groups, it was assumed that there were no inter-individual differences within experience categories.

The hypothetical frequencies in the chi-square test have to be equal to or greater than five, or the frequencies must be grouped. Since grouping was necessary in most of the tests described previously, loss of sensitivity was suspected. To verify the conclusion (based on the chi-square tests) that intra-individual error is the same, the homogeneity of variance of the Company group errors was tested.

The results of this and the remaining tests of homogeneity of variance indicated that intra-individual variation is not significantly different among observer for Elements I, III, or the total cycle. The hypothesis of homogeneity of observer variance for Element II is rejected at the .05 level of confidence, and can be just rejected at the .01 level. Since the variance of each observer's error is based

on thirty observations, the .01 level seems most logical to use.

The analysis of variance by classification divided the variance of an observed quantity into meaningful components and then tested the significance of the components by means of F tests. Thus, in this analysis, the variations of deviation of elemental times is divided into components due to experience and elements and interaction to test the significance of both.

The following hypotheses were tested:

a. *Hypothesis 1:* The mean error is independent of the length of element. The test of this hypothesis is made independent of the experience effects.
   Hypothesis 2: Experience does not affect the mean watch reading error. The test of this hypothesis is made independent of the length of element effects.
   Hypothesis 3: There is no interaction between length of element time and experience effects.
   Hypothesis 4: Variances of individuals are homogeneous and independently distributed.
b. The level of significance was chosen to be .05.
c. The statistic used was the F test. For hypothesis 1, and hypothesis 2, the numerators for F are the mean square for length of element times and experience means square respectively. If hypothesis 3 is rejected, the denominator for each ratio is the interaction mean square.
d. The assumption that observations are from normal populations with homogeneous variance and that the length of element time and experience effects are additive.

The results indicated that the observed value is not significant and so it was concluded that there was no interaction. Therefore, the two estimates of variance, interaction and within subgroups were pooled.

The analysis showed that experience has no significant effect on variability of watch reading, and that the experience effects are significantly smaller than would be expected.

Also, the length of the elements had no effects on variability of watch readings. All these results agree with the results of the chi-square tests.

These facts again justify the conclusion that element length and experience do not affect the distribution of time-study watch reading errors for time-study observers.

Implications

The results of the chi-square tests indicate that inter-individual differences are not consistently significant except among inexperienced time-study men (Undergraduate group) when they are timing visual break point elements of magnitudes from .03 to .10 minutes. Table 1 shows that men from different companies having as much as three years of experience may exhibit significant inter-individual differences in watch reading ability when timing short elements (.03 to .04 minutes).

Inter-individual differences were not found significant when timing long elements (.07 to .11 minutes) except when the group with no experience timed elements of such length (Element II) preceded by a very short element (.03 or .04 minutes—Element I).

It is interesting to note that only the inexperienced Undergraduate group showed inter-individual differences in recording total cycle times. Apparently the errors in reading individual elements cancel out and do not affect total cycle time errors.

Inter-individual differences are exhibited most by men with little or no experience in time-study; individuals with experience are not significantly different. The inter-individual differences appeared in the Graduate group upon testing the experience effects, but it was due to one man whose experience was not primarily in time-study. When this man's data was excluded, errors were not significantly different among the Graduate group as shown in Table 2.

TABLE 1

Summary of Chi-Square Test of Inter-Individual Differences in Distributions of Watch Reading Errors Within Experience Subgroups, Element I

Experience Subgroup	Group			
	Undergraduate	Graduate	Company	$\frac{2}{R}$
0				
n	12	2		16
χ^2	25.91*	2.118		28.028*
2.05	21.220	5.99		26.30
2.01	26.20	9.21		32.0
3–18M.				
n		4	4	8
χ^2		3.645	11.709*	15.354
2.05		9.49	9.49	15.50
2.01		13.31	13.31	20.10
1½–3Y				
n		4	2	6
χ^2		12.053*	2.44	14.493*
2.05		9.49	5.99	12.6
2.01		13.31	9.21	16.8
3Y				
n			6	
χ^2			7.07	
2.05			12.60	
2.01			16.80	
2c				
n		10	12	
χ^2		17.816	21.219*	
2.05		18.30	21.00	
2.01		23.20	26.20	

* Significant at .05 level of confidence.

TABLE 2

Recomputation for Graduate Group Only—One Person Excluded

	Element			Total Cycle Time
	I	II	III	
n	4	4	4	4
χ^2	2.9754	4.1325	5.855	2.090
2.05	9.49	9.49	9.49	9.49
2.01	13.31	13.31	13.31	13.31

Conclusion

The primary cause of errors in watch reading is variability within the observer, i.e., intra-individual differences except when the observers have less than three months experience.

There is every indication that the intra-individual differences are not statistically different from one time-study man to another in a group and for elements of length .03 to .11 minutes unless an element of .10 or .11 minutes is preceded by a short element .03 to .04 minutes. From the results it appears that the Company group measured short elements with fewer correlated errors than the Graduate group which represents many plants. This apparently does not affect the variance of the error but would change the mean time for an element.

These intra-individual differences are not reduced as the time-study man gains experience except possibly for the timing of an element following a short element of .03 or .04 minutes.

From these conclusions it appears that the magnitude of watch reading error cannot be reduced by better selection of time-study trainees, but should be effected by training programs directed at all time-study men in a company regardless of experience. Such training should attempt to eliminate correlated errors and to show each man better watch reading methods.

It also appears that the "rule of thumb" limiting time-study elements to at least .05 minutes is valid. One major cause for lack of homogeneity of variance within the Company group when recording Element II appears to be based on the fact that it was preceded by a short element of .03 to .04 minutes. Furthermore, there is every indication, in the distribution of errors for the Graduate group, that the errors in reading Elements I and II are correlated.

Finally, the standard deviations observed in this experiment for watch reading errors ranged from .005 to .01 minutes and averaged between .007 and .008 minutes. This agrees closely with the results of Mr. Lazarus for visual break point elements. Apparently the variance of errors about the rounded true time is not substantially larger than that around the true time to the nearest .0001 minute.

NEW CHALLENGES

INDUSTRIAL ENGINEERING IN MEDIUM-SIZED BUSINESS

The Status of Scientific Management

Daniel Seligman
Assoc. Editor Fortune Magazine

AUTOMATIC DATA PROCESSING

Application of Automatic Data Processing Systems and Skills Required

Dr. Howard Aiken
Director Computer Lab.
Harvard University

Effect of Equipment Trends

Dr. Samuel N. Alexander
Chief Data Processing, Div.
National Bureau of Standards

Also Presentation on-

Organizing for Automatic Data Processing

HUMAN ENGINEERING

Dr. G. H. Mowbray
Applied Physics Lab.
The Johns Hopkins Univ.

Dr. Lee Christie
Operations Research Office
The Johns Hopkins University

Dr. Robert B. Sleight
President, Applied Psychology Corp.
Washington, D. C.

Ladies Program:

An entertaining program has been developed which will include sightseeing and social events with ample opportunity for shopping and visiting. Some of the National Capitol highlights to be visited are the US Capitol (where a session of Congress will be viewed), the White House, Mt. Vernon (George Washington's homesite), the Lincoln Memorial, and the Tomb of the Unknown Soldier.

Seventh Annual

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS

CONFERENCE AND CONVENTION

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Probability Theory
DR. ROBERT B. FETTER
Ass't. Prof. of Industrial Management MIT

Monte Carlo Methods
STROTHER WALKER
Operations Research Office
The Johns Hopkins University

Linear Programming
DR. HAROLD KUHN
Bryn Mawr College

Also Presentations On-
Queueing Theory
Game Theory

WORK MEASUREMENT

Problems in Work Measurement
RALPH PRESGRAVE
J. D. Gordon & Woods Ltd.

Indirect Work Standards
H. B. MAYNARD
President, Methods Engineering Council, Pittsburgh, Pa.

Also Presentation on
Memo-motion Techniques

CONTROL TECHNIQUES

An Algebraic Approach To Profit Control
DR. RAYMOND VILLERS
Assoc. Prof. of Ind. Eng.
Stevens Inst. of Tech.

Measuring Work by Sampling Methods
RALPH M. BARNES
Prof. of Eng. & Prod. Mgt.
University of Calif.

Inventory Control
DR. H. A. SIMON
Carnegie Inst. of Tech.

CURRENT PRACTICES

SHOP TECHNIQUES

Metals Forming Survey
DR. RALPH LEITER
The Budd Co.

Noise and Vibration Control
DONALD VANCE
Korfund Co. L. I. City, NY

Also Presentation On-
Program-Controlled Machinery

AUTOMATION

Presentations on-
Theory of the Production Process
Technological Advances

OPERATIONS RESEARCH APPLICATIONS

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Touche, Noven, Bailey & Smart
Detroit, Michigan

WARREN E. ALBERTS
Dir. of Ind. Eng.
United Airlines, Chicago

(Continued on Opposite Page)

RECENT READABLES*

AUTOMATION

"Automation: A New Dimension to Old Problems", G. P. Schultz & B. B. Baldwin, *Annals of American Economics*, (2162 Florida Avenue, Washington 8, D. C.) $1.00.

An explanation of the kind of technological change which automation represents, and an analysis of some of its likely effects. For more particular consideration, the authors single out four key areas: (1) the skills that automation will require of the labor force; (2) its effect on job classifications & seniority rules; (3) its implications for education & training; and (4) the problem of displacement.

"Digital Automation", M. L. Klein, F. K. Williams, and H. C. Morgan, *Instruments and Automation*, November, 1955, page 1930.

This article is an introduction to the binary number systems used in computing machines. It includes a discussion of the meaning of any number system, decimal numbers, straight binary numbers, decimal binary numbers, trinary numbers, octonary numbers, binary-coded decimal numbers, and cyclic coded numbers. Of basic importance are the techniques for addition, subtraction, multiplication and division with binaries.

A family of five articles on office automation prepared under the direction of senior editor James K. Blake, *Dun's Review & Modern Industry*, October, 1955.

Art. 1: "The Fitful Beginnings of Office Automation," p. 57. Prediction that what we have seen thus far in the field of office automation is "only the beginning". Cites planning of some companies which envision central data processing centers as entities entirely separate from remainder of the enterprise. But cautions that this cannot occur overnight primarily because of management's inability to correlate all ramifications and implications which this new approach encompasses. Another obstacle at present is lack of uniformity in equipment—manufacturers will have to get together and standardize on "common language" medium, equipment feed speed, etc. The general rule today appears to be a cautious approach with conversion of one system or unit at a time.

Art. 2: "Good Planning Integrates Order Processing for Better Customer Service", p. 69. Case history of IDP installation by Scott Paper Co. to cover its sales order-acknowledgment-shipping paperwork procedure. Time to process rush order thru to any one of eight plants was reduced to 15 minutes. Installation time, from first serious planning steps until system had been "debugged" and was operating satisfactorily, took 15 months. Schematic flow chart of procedure is included.

Art. 3: "27 Companies Evaluate the Impact of New Data Processing Techniques", p. 77. Comments, based on experience, pointing out popular misconceptions and problems about this field and offering samples of approaches which have proved successful in specific instances.

Art. 4: "Here's How The Producers Look at the Fast-Moving Data Processing Developments", p. 93. Equipment manufacturers point out a few of their own problems—among themselves and with customers—as well as possible ways to resolve these difficulties.

Art. 5: "Where Do You Go From Here?", p. 105. Reviews the planning steps involved in the transition to office mechanization and provides a bibliography of the latest and best publications and films which can be employed in developing an understanding of appreciation for the subject, including the limitations of the present equipment and techniques.

"Automation—Its Development in Metalworking", by A. Ashburn, *Mechanical Engineering*, p. 958, November 1955.

This is an historical summary which answers the questions: Automation—How did it start? What does it mean? Where will it go? Conclusion—Automation is not a second industrial revolution, but a logical step in the evolving science of production methods. Some necessary developments for the automation of metalworking discussed include: New Standards, Materials & Power Sources, The Assembly Line, Transfer Machines, High-Speed Machining, Automatic Machine Control, Automatic Size Control, Tape Controls, Automatic Tool Controls, and Assembly Machines.

GENERAL

Guides to Effective Production Management: Communication—Coordination—Controls. Publications Sales Dept. P, American Management Association, 330 W. 42nd St., New York 36, 48 pages, $1.75 ($1.00 to AMA members).

A series of five papers written by plant men on these subjects: What top management wants from production; Coordination of manufacturing and warehousing operations with traffic and transportation; What top management should expect from quality control; Controlled inventories mean reduced costs; and Role of the production executive in labor relations.

Industrial Engineering Terminology, Order Department, The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, 50 pages, $1.50.

Brief definitions of 500 industrial engineering terms. Most can be understood even by non-experts in the field.

INVENTORY CONTROL

"Company Approaches to Production Problems", Number 220, Manufacturing Series, Published by American Management Association, 330 West 42nd St., New York 36, $1.75 ($1.00 to AMA members), 88 pages.

One of the principal sections of the booklet pertains to inventory control and management. It contains papers by several authors representing different industrial activities, namely appliance manufacturing, instrument making, machine tool manufacturing, and food processing. Among the topics discussed are the dimensions of inventory, specifically volume, value, and time. Consideration is also given to the subject of production rate adjustment to take care of fluctuations in demand.

* The Editor wishes to acknowledge the invaluable assistance received from Messrs. C. E. Colvin III and D. J. Fournet, Jr., both of the Ethyl Corporation, Baton Rouge, La., in preparing this issue's listing.

OPERATIONS RESEARCH

"Distributions of Solutions of a Set of Linear Equations (with an Application to Linear Programming)", M. M. Babbar, *Journal of the American Statistical Association*, p. 854, September 1955.

This article presents an approach to deriving distributions of the variables representing the solution of a set of simultaneous linear equations, when the coefficients are subject to random errors. The distribution of a linear function of these variables is also discussed.

MATERIALS HANDLING

Handbook of Manual Materials Handling Equipment. Caster and Floor Truck Manufacturer's Association, 27 Monroe St., Chicago 3, 49 pages, $1.00

An illustrated manual to help you select and use manual handling equipment including industrial wheels, casters, two-wheel hand trucks, industrial platform trucks and trailers, pallets, and skids. Tells what the product is, why it's made, how it's made, how it's used, how to select the unit you need, and how to use catalogs on that type of unit.

"Ingenious Tooling Speeds Pallet Loading", p. 84, *Modern Materials Handling*, November 1955.

A new pallet loading system developed by a leading wax company handles the increased output of four production lines and has halved the number of operators needed. In order to keep costs low, components of standard materials handling equipment were used. A combination of roller & belt conveyors, hydraulic lifters & pullers and a standard pallet dispenser has, the company claims, virtually eliminated operator lifting and fatigue and increased loading speeds.

"Applying Engineering Economics to Materials Handling—Part II", J. B. Day, p. 87, *Modern Materials Handling*, November 1955.

This is the second in a two-part series that outlines fundamental rules for cost reduction. Five fundamental rules discussed in Part I were reported in the last issue of the Journal. The remaining six covering work simplification, operating speed, equipment replacement, safety, fatigue, and method of cost reduction are discussed in this article.

QUALITY CONTROL

"The Application of Sampling Procedures to Business Operations", H. L. Jones, *The Journal of the American Statistical Association*", p. 763, September 1955.

The article was written for the purpose of giving executives an insight into sampling theory without confusing them with mathematical symbols or unexplained technical terms. The procedures used are grouped into three broad categories—Judgment Sampling, Systematic Sampling, and Random Sampling—the relative advantages of which are discussed. Various ways of minimizing the cost of random sampling are discussed.

"Quality Control Through Statistical Methods", Norbert Lloyd Enrick, *Institute of Textile Technology*, Modern Textiles Magazine Handbook No. 3.

This manual is intended to present the techniques of statistical quality control for use in the textile industry. Subjects covered include; frequency distributions, averages, measures of variation, and sampling.

"Statistical Principles of Testing", J. Mandel, *Industrial Quality Control*, p. 18, November 1955.

Many problems in science are solved by analyzing the small differences in the numerical values of a few measurements. In determining these differences, it is necessary to guard against biases introduced by the testing procedure. One of the principal functions of statistical design is to detect and neutralize these biases. The author illustrates this approach with examples involving a study of the homogeneity of a chemical sample, a road test of automobile tires to determine rate of tread wear, and a study of the aging characteristics of natural and synthetic fibers.

WORK MEASUREMENT

"Maintenance Problems", D. W. Karger, *Plant Engineer*, October 1955, p. 114.

Work simplification used for problem solving which answers the questions: how to study maintenance problems, how to get the facts, and how to find the solution? Stresses the importance of isolating and defining the problem and getting all the facts.

"Simplified Maintenance Standards", Robert S. Smith, *Plant Engineer*, Oct. 1955, p. 87.

This article answers such questions concerning maintenance standards as: How much do they cost? Can we use them profitably? Can a small plant employ these standards? How do they work? The example described is a system used in a pipe shop in which time standards have been set for the repetitive jobs of a pipe fitter: cutting and threading pipe, making screwed and flanged connections, etc. The necessary staff and paperwork for the system are described in detail.

"Some Principles of Methods & Motion Study as Used in Development Work", R. R. Farley, p. 20, General Motors Engineering Journal, Nov.–Dec., 1955.

The author's own abstract is as follows:

"In today's manufacturing plant; the machine, the assembly operation, or the process all have been designed, obviously, for the best possible performance and efficiency. But all machines and processes—even the so-called completely automatic—are controlled by human operators. Thus, it is the man-machine combination which results in the product and the overall output is evaluated as man-machine performance. Designers of machines and industrial operations, therefore, must give attention to principles applying to the human element in the man-machine relationship for the proper functioning and ease of operation of the machine. In General Motors, equipment is designed on the basis of the man-machine system. Such designs require the application of a number of principles of methods and motion study affecting, for example, work-space limits for the female or male operator, manual activity of the operator, the force and the motions which the operator can best use, and the proper arrangement of information for visual response."

WORK SIMPLIFICATION

"Work Simplification—Improving Materials Handling", Lillian Stemp, *Plant Engineering*, August 1955, p. 96.

This article stresses the importance of keeping an open mind during the search for improvements in materials handling operations. The engineer should accept only logical "No's", rather than dogmatic "No's." Several illustrations of improved materials handling operations are included to serve as imagination jolters.

BOOKS

"*Basic Principles of Parliamentary Law and Protocol*", Marguerite Grumme, 3830 Humprey Street, St. Louis 16, Missouri, 1955, 68 pages, $1.

This pocket size manual is a handy reference which contains the Basic Principles of Parliamentary Law (based on Robert's Rules of Order). It is a compact visual aid for referring to basic rules, officers' duties and members' rights. This manual also contains a Basic Chart of Motions for quick reference

when presiding. It also contains a Basic Convention Agenda and Notes, and a special section on Protocol outlines correct procedures and courtesies for the meeting, the officer and member.

"The Design and Analysis of Experiments", Oscar Kempthorne, N. Y., John Wiley and Sons, Inc., 631 pages, $8.50.

The book contains 29 chapters. The early chapters provide a discussion of scientific method and the principles of experimental design exemplified by Sir Ronald Fisher's famous tea-tasting experiment. There follows a brief summary of elementary statistical theory, the normal distribution, and derived sampling distribution, and a discussion of such important concepts as orthogonality, estimation, and likelihood ratio tests. A discussion of least squares theory and the general linear hypothesis also appears. For the reader who wishes to apply the techniques in fields other than agriculture, some caution is necessary. It has sometimes been rashly assumed that the strategy of experimentation specifically developed for agricultural application is directly transferable into all other fields. This is not so because of the long time necessary to gather data for an agricultural experiment and the large experimental error inherent in such data.

"Motion and Time Study", Benjamin W. Niebel, Richard D. Irwin, Inc., Homewood, Illinois, 1955, 433 pages, $6.

A basic college text which may be used for reference or training. Includes sections on work sampling, predetermined time systems, standards for indirect work, and allowances. Proven industrial methods and tools are covered.

"Process Engineering Economics", H. E. Schweyer, McGraw-Hill Book Company, Inc., 330 West 42nd Street, N. Y. 36, New York, 1955, 409 pages, $7.50.

Material in this book is predominantly slanted to engineers in chemical production and related industries. Subjects considered in some of the 12 main chapters are as follows: value of money equivalence, amortization, capital requirements for process plants, rate of return and payout time replacements, economic balance and inventory in process operations, and economic analysis of a complete process.

"Profit Management and Control", Fred V. Gardner, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York, 285 pages, $6.

Written for those plant operating men who feel the need for faster and tighter control over their operations. If the cost of keeping costs has become too high, and if methods and procedures of keeping costs have not kept pace with physical development, this book may help to get the figures needed to run the plant without undue duplication of effort. Basis of the technique is the breakeven point.

"Manual of Industrial Engineering Procedures", edited by John A. Patton, William C. Brown Company, Publishers, 915 Main Street, Dubuque, Iowa, 1955, 144 pages, $10.

This manual describes the basic step-by-step procedures for the 10 essential programs for better management controls. These are: wage incentive program, job evaluation program, cost control, production planning and control, plant layout, sales and distribution analysis, personnel selection, employee training, inventory control, and materials handling. Lengthy bibliography included.

"Techniques of Plant Maintenance and Engineering—1955", Clapp and Poliak, Inc., 341 Madison Avenue, New York 17, New York, 218 pages, $7.50.

This book consists of material presented in the form of papers and discussions at the last plant maintenance and engineering conference held in Chicago. Some of the topics included in the twenty-three papers are the following: the wants of both maintenance and management people in their relation with each other, maintenance force organization, cost control, preventive maintenance planning and scheduling, and communication between management and maintenance.

"Modern Office Methods", C. L. Littlefield & R. L. Peterson, Prentice-Hall, Inc., 1955, New York, 562 pages, $9.00.

A concise presentation of office organization, equipment and methods that should be of interest to the Industrial Engineer concerned with office activities.

"The Automatic Factory", Report of the Conference held at Margate, June 16–19, 1955, The Institute of Production Engineers, 10 Chesterfield Street, London, England, 228 pages.

A report of twenty-one presentations dealing with various facets of automation—ranging from general management problems to technical problems and applications to social and educational problems resulting from automation. A wealth of information reported by leading British engineers.

"The Automatic Factory—A Critical Examination", Stephen A. June et al., Instruments Publishing Company, 1955, Pittsburgh, 88 pages.

This report attempts to bridge the gap between the theoretical concepts and the actual industrial developments of the Automatic Factory. It presents the basic concepts of automation and illustrates proven applications. Far from being a thorough treatment of the subject, but very thought provoking.

"Introduction to the Theory of Errors", Yardley Beers, Addison-Wesley Publishing Company, 1953, Cambridge, $1.50, 65 pages.

This small volume will be of value to those involved with measurement problems and consideration of errors. With additional use of mathematical and statistical techniques in Industrial Engineering this will include many individuals. A fundamental treatment—very good.

"Prelude to Mathematics", W. W. Sawyer, Penguin Books, 1955, Baltimore, $.65, 214 pages.

A very readable and intriguing presentation that will be of interest to the Industrial Engineer who wants to review his mathematical training. The author has great facility in explaining how and why mathematics can be used.

"The Psychology of Industrial Conflict", Ross Stagner, John Wiley & Sons, Inc., 1956, New York, $8.00, 550 pages.

A systematic examination of union-management relations as a psychological problem, drawing upon basic material in the fields of the social sciences. The book is oriented toward achieving "Industrial Peace" by better understanding of the sources of dissatisfaction and how to avoid them. It should be of interest to all Industrial Engineers.

"Improving the Work Skills of the Nation: Proceedings of a Conference on Skilled Manpower", National Manpower Council, April 27–May 1, 1955, Arden House, Harriman Campus of Columbia University, 225 pages, Columbia, cloth $3.50x, paper $2.25x.

The National Manpower Council was established at Columbia University in 1951 to study significant manpower problems and policies. These papers from the 1955 Conference which was attended by sixty-nine representatives of industry, labor, education, and government, focus attention on the ways in which the secondary schools, industry, and the local community can contribute more effectively to strengthening the country's skilled manpower resources.

INSTITUTE INTERESTS

AIIE and EJC

The growing recognition of the Industrial Engineer is vividly illustrated by the recent election of AIIE to associate membership in Engineers Joint Council. EJC, organized in 1941, is the one nation-wide body which speaks for the entire engineering profession as a group on matters of economic, political and social impact. It is the engineer's Department of State.

EJC membership comprises at present

the four founder societies (ASCE, AIME, ASME and AIEE)
American Institute of Chemical Engineers
American Water Works Association
Society of Naval Architects and Marine Engineers
American Society for Engineering Education
American Society of Refrigerating Engineers
AIIE

EJC aims to

promote cooperation among the various branches of the engineering profession
advance the science and profession of engineering
develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful through the services of its members
advance the general welfare of mankind through the available resources and creative ability of the engineering profession

EJC's activities are quite widespread so that just a few can be listed here. For example, Engineers Joint Council

acts as coordinating agency between the engineering profession in the United States and abroad
cooperates with the National Science Foundation in basic research in engineering sciences
continues its widely acclaimed services through periodic surveys of employment conditions (earnings, effect of contemplated legislation upon engineers, relations to labor unions, etc.)
aids, through its Engineering Manpower Commission, in establishing the importance of the engineering profession to the national economy and promotes the most effective utilization of engineers.

AIIE membership in EJC will be of very real significance to every member of the Institute as it provides, for the first time in the history of Industrial Engineering, a voice for our field in the top councils of the profession.

ALEX W. RATHE
Director-at-large and
AIIE Representative at EJC

ATLANTA CHAPTER

About 50 members were present at the November meeting, one of the most enjoyable this year. A songfest, of sorts, took place during the social hour before dinner, with accordion accompaniment.

After dinner, Capt. W. A. Brooks, 1st Vice President of the Atlanta Chapter, introduced the speaker for the evening, General A. R. Glancy. General Glancy, one-time Vice President of General Motors and head of the Pontiac Division, now is a resident of the Atlanta area and his business, A. R. Glancy, Inc., is most active in this area. His fifty years of experience with du Pont, General Motors and the Federal Government made him well qualified to speak on "Labor-Management Relations."

Using instances throughout his whole life as examples, General Glancy developed the change in these relations in the 20th century. His theme of "What can I give to you young folks" stressed the faults of management that augmented the labor movement, and the faults of labor today. In some very humorous stories, he demonstrated that management techniques of yesterday are not very useful today. In a more serious vein he discussed the abuses that are currently found now that the pendulum has moved in the other direction. He concluded his talk with an appeal to personal initiative and ambition in order that the "uncommon man" who made this nation great, will not become extinct. Even though much of his presentation was humorous in nature, the thoughts he left with the group were sobering and useful.

AKRON CHAPTER

On November 16, 1955, the Akron area, comprised of Summit and Medina counties, became the 52nd area in the United States to have established in it a chartered chapter of the American Institute of Industrial Engineers. The charter presentation meeting was held at Sanginiti's Restaurant and the charter was awarded to a group of twelve registered AIIE members who began organizing the Akron Chapter last February. The charter was presented by Mr. J. L. Southern, Executive Secretary of AIIE.

The Akron Chapter now has, in addition to the twelve registered members, some twenty or more prospective members on its attendance roll. The Akron Chapter will meet each third Wednesday night of the month from October through June. Programs for the coming year are now being prepared and will soon be announced. The program will consist of nationally known speakers, and demonstrations of interest to the industrial engineer. Persons who believe they are qualified for membership and are interested should contact the chapter secretary, James C. Bryan, 2607 Overbrook Road, Cuyahoga Falls.

Other officers installed at the November meeting were: President, John P. Dandalides; Vice President, Charles L. Deal and Treasurer, Ned Martin, Jr.

BATON ROUGE CHAPTER

The Baton Rouge, Louisiana Chapter held its November meeting in the Agricultural Engineering Auditorium of Louisiana State University. The guest speaker was Mr. Frank Kean, Managing Partner of Kean's Laundry and Dry Cleaners of Baton Rouge. His topic was "Industrial Engineering in The Laundry" and he pointed out just how the quality and production at Kean's has been increased as a result of the studies and recommendations of industrial engineers. He strongly proved that Industrial Engineering can be of service to other fields besides industry and manufacturing. His presentation was well received by the Chapter members as well as a group of guest Louisiana State University engineering students.

The December meeting was held for the purpose of reviewing old business and transacting new business. The membership was given the opportunity of learning what has been done thus far and what the future plans are, as the various Committees presented reports on their progress and proposals.

E. L. SLAGLE ADDRESSES BATON ROUGE CHAPTER

During his visit with the Baton Rouge, Louisiana Chapter in October, 1955, Ed Slagle toured some of the local industries and the Louisiana State University. He is shown at the Kaiser Aluminum and Chemical Corporation.

Left to right: B. J. Herman, plant's Chief Industrial Engineer and 1st Vice President, Baton Rouge Chapter, AIIE, E. L. Slagle and J. A. Wilson, Baton Rouge Works Manager.

The Baton Rouge Chapter is really branching out. We now have approximately thirty-eight members, including one in New Orleans and one in far away Jackson, Mississippi.

We are very proud that our Chapter President, George Anton, has been appointed to serve as a member of the National Committee for Professional Registration by S. E. Scharff, National Committee Chairman. In this capacity, George will act as Chairman of the South West Region and will direct the activities of the member chapters of this region. He will further represent the South West Region on the National Committee.

CENTRAL INDIANA CHAPTER

The Central Indiana Chapter met on December 20th, 1955, in the Purdue University Memorial Union. The regular buffet supper and social hour preceded the stimulating program.

The program for the evening centered around the subject, *The Future Outlook for Industrial Engineers* and was discussed by a panel of the three following Purdue professors:

Professor H. T. Amrine presented a broad coverage of possible trends, highlighting operations research and statistical methods. Professor Amrine is well known as the Head of the Industrial Engineering Department at Purdue University and also as the first President of the Central Indiana Chapter.

Professor T. E. Bartlett developed the application of operations research techniques in Industrial Engineering. Professor Bartlett is a new Industrial Engineering staff member at Purdue. He has six years of consulting experience in industry.

Professor I. W. Burr covered the application of statistics to more predictable solutions for production problems. Professor Burr is the author of the well-known text, "Engineering Statistics and Quality Control", McGraw-Hill, 1953.

All of us are interested in looking over the Industrial Engineering horizon, and this meeting provided a chance to hear some good ideas on the subject and contribute some of our own.

CINCINNATI CHAPTER

The Cincinnati Chapter held their Cost Reduction Conference January 26 27 28 at the Netherland Plaza Hotel. As in each past year the Conference was "bigger and better" than the previous one.

In February Professor Amrine of Purdue University will speak on "Should Industrial Engineers Participate in a Salary Plan".

The March meeting will be the yearly Union Discussion.

The April meeting will be a "Career Night" for the Cincinnati area High School students interested in Industrial Engineering as a profession. A panel type program with a Moderator from both Industry and Education will be conducted. A need for such a type of program has been apparent for a considerable period of time and it is hoped that this first attempt to present such a program will be successful.

CLEVELAND CHAPTER

Mr. Edward L. Slagle, National President of AIIE, spoke on January 5 at a meeting of the Cleveland Chapter at the Case Institute of Technology. He gave an interesting and informative talk on the subject, The Industrial Engineer's Share of the Total Management Function. He also presented a charter to the recently formed student chapter of AIIE at Case Institute of Technology.

On March 15 and 16 a conference on "Automatic Control, Industrial Engineering at the Crossroads" will be held at the Hotel Cleveland, Cleveland, Ohio, under the auspices of the Cleveland Chapter, AIIE. This conference will feature an examination of the whys, whats, and hows of automatically controlled manufacturing equipment and its effect on the Industrial Engineering profession.

The program will consist of morning, afternoon and evening sessions March 15 and morning and afternoon sessions March 16. Concurrent talks will feature nationally known authorities on Automatic Control. Registration is $25.00 for AIIE members, including all sessions, two luncheons, and one dinner.

For registration or additional information contact L. A. Tuzi, Case Institute of Technology, 10900 Euclid Avenue, Cleveland 6, Ohio.

DAYTON CHAPTER

On December 3, 1955, Mr. Thomas E. Bartlett, Professor of Industrial Engineering at Purdue University, spoke at a meeting of the Dayton Chapter on the subject of Practical Applications of Linear Programming.

Many have heard and read about the higher mathematics involved in linear programming. Professor Bartlett explained various applications in terms that all can understand. This is the type of presentation needed for a clearer picture of this latest concept of scientific industrial management.

The speaker has a Masters Degree in Industrial Engineering from Columbia University. His familiarity with the subject stems primarily from his work at Hughes Aircraft Corporation as a Senior Industrial Engineer. He headed a group on systems analysis which led to design work for digital computer applications. At present he also is a member of the management sciences research group at Purdue.

On January 10, 1956, Dr. E. W. Martin, Applied Science Division, International Business Machines Corporation, spoke at the monthly meeting of the Dayton Chapter. His subject was: Are Machines Smarter Than I Am?

Dr. Martin's presentation centered around the relatively small ($100,000-$200,000) electronic digital computer of the type which the industrial engineer is likely to encounter. The purpose of this meeting was to inform the industrial engineer of what he should know generally about this electronic computer to utilize it; how it works; how a problem is set up; examples of types of usage and the kinds of problems it will and won't solve; and a look at the future in this field.

Dr. Martin is a graduate of Georgia Tech (B.S., E.E., 1946) and Ohio State (PhD, math 1952). He has been associated with IBM, a leader in the field of computers, for three years in the Applied Science Division.

HOUSTON CHAPTER

The First Annual Work Measurement Clinic sponsored by the Houston Chapter, American Institute of Industrial Engineers and

the Industrial Engineering Department, University of Houston, drew more than 150 industrial representatives, a fine attendance even for Houston. Dr. Lillian M. Gilbreth spoke to over 200 people at the closing banquet.

The Clinic was designed to serve industry in the Gulf Coast area by treating with phases of work measurement particularly significant to the industry of this region. Emphasis was placed on measurement of indirect and non-repetitive type labor. The speakers represented a firm of management consultants, the industrial engineering staff of a very large corporation, management, and the industrial engineering department of an engineering school. They presented papers and invited discussion on subjects ranging from management aspects of a work measurement program to methods and techniques of applying work measurement in a process industry.

Dr. Gilbreth charmed her banquet audience but pulled no punches in pointing out that labor leaders are already clamoring for shorter hours, and the hours probably will be shortened. This will bring about some social changes because of the increased leasure time.

"We've got to think how quickly automation is coming, what to do with it, and whether we shall have to re-define leisure," Dr. Gilbreth said. "We are the branch of engineering to deal with things close to the people. We have the responsibility of experts." People must be educated for the expected leisure through cooperation between universities and libraries and the people on industrial jobs.

General A. D. Bruce, President, University of Houston, by his remarks opening the Clinic and at the banquet exemplified the graciousness with which the University played host to this conference.

LOUISVILLE CHAPTER

Dr. Mel Salveson, Manager of Consulting Services Division of General Electric Company, spoke at the November meeting of the Louisville Chapter on the subject, Engineering Methods as Applied to Management.

Dr. Salveson described the use of engineering investigation to clarify some of the important managerial functions. Since they are not anyone's direct responsibility, all units of management are affected but none given the time nor money, usually, to work on them. Each unit of management is generally thoroughly acquainted with its own province but has only a hazy idea of the other branches of management. This was illustrated by Dr. Salveson when he described the drawing of organization charts by various members of his company during training periods.

A joint meeting of all the Engineering Societies in Louisville was held on December 5 at the University of Louisville. It was a presentation by the Do-All Company of Des Plaines, Illinois. The subject was Civilization Through Tools and related the growth of civilization with that of tools. There were extensive displays of tools used down through the ages (gathered from museums all over the world), along with a lecture giving the historical background of the tool development.

Mr. Bleick Von Bleicken, President and General Manager of the Institute of Modern Management, Louisville, spoke at the January 18 meeting of the Louisville Chapter. His subject was Predictability of Human Behavior. Born in Tanganyika, East Africa of German missionary parents, he returned with his parents to Germany at the age of 12. He attended Gottingen University. He came to the United States in 1922 and obtained a B.S. degree in Social Science at Boston University. He did postgraduate work at Manhattan College, Columbia, and Harvard Business School. Shortly thereafter he entered the Industrial Relations field. He worked for a Louisville engineering firm and remained here, opening his own business in 1954.

MISSISSIPPI VALLEY CHAPTER

Predetermined time systems—the highly detailed study of time as involved in various human motions—was discussed on December 10 at a conference of the Mississippi Valley Chapter of AIIE at Hartman's restaurant, Davenport, Iowa.

The conclave was designed to give plant executives, industrial engineers, and industrial relations personnel a better understanding of human motion study, which is becoming an increasingly important industrial engineering technique.

The welcoming address was given by Joseph Moquin, president of the Mississippi Valley Chapter. W. H. Hudson, professor of industrial engineering, State University of Iowa, moderated the morning discussions. He was introduced by Frank M. Dickey, of the operating department of Deere & Company.

Speakers at the morning session included Dr. Irwin P. Lazarus, founder of the ordnance predetermined time system and assistant director of the ordnance management engineering training program at the Rock Island Arsenal, and Clifford Sellie, manager of the Chicago office of the Work Factor Company, and organizer of the Work Factor Associates of Chicago.

In the afternoon, Matthew Porosky, president of the Eagle Signal Corp., Moline, introduced Prof. J. Wayne Deegan, chairman of the Department of Mechanical Engineering, State University of Iowa, who moderated the session. Speakers included William Hyde, senior consultant and assistant to the vice president in charge of the New York division of the Methods Engineering Council; A. B. Segur of the A. B. Segur Co., Oak Park, and L. N. Chambers, president of the L. N. Chambers Co., management consultants.

METROPOLITAN NEW YORK CHAPTER

The Metropolitan New York Chapter repeated its success of last year with a movie night for its members and their guests. The special showing of a number of unusual, informative and entertaining films was held on February 15th at the National Cash Register Auditorium in New York City.

The program covered some of the most recent developments in Industrial Engineering, such as automation and ratio delay studies. Also on the program were two excellent films on subjects of general and perennial interest. One of these was a March of Time presentation showing the importance of public relations to business and government; the other was a case study of labor negotiations in a steel factory. In addition, there were two films of special appeal to our non-technical guests.

The films presented an easy way of learning about some of the most recent developments in our field. They also gave us an opportunity to show our wives, girl friends and associates what Industrial Engineers are doing.

PENINSULA CHAPTER

On November 8, 1955, the Peninsula Chapter held its regular monthly meeting at Stanford University. Mr. Richard Rabbett spoke on the subject of Data Handling with Medium and Large Scale Computors. Mr. Rabbett is the West Coast representative of IBM to the Pacific Telephone and Telegraph Company. He holds the BA and MBA degrees from Stanford University and has served four years in the U. S. Navy. Mr. Rabbett discussed the potentialities of the medium sized computors and punch card systems, and also the large machines, from a service bureau viewpoint. On this basis the problem-solving ability of these computors is available to even the smaller firms.

On December 13, 1955, Mr. Clark Henderson spoke at the regular monthly meeting of the Peninsula Chapter on the subject of Quantitative Methods in Material Handling Studies. Mr. Henderson, now with Stanford Research Institute, was formerly on the Industrial Engineering Faculty of Stanford University. He has also been associated with the Boeing Airplane Company and the

U. S. Navy. In a recent study made by Mr. Henderson and others of the Stanford Research Institute staff, a more quantitative approach than is usual was taken to the materials handling problems involved.

Mr. John P. Troxell spoke at the regular monthly meeting of the Peninsula Chapter on January 10, 1956, at Stanford University. His subject was Arbitration in Labor-Management Relations. By increasing his learning of this subject, the Industrial Engineer can pursue a course of action which will avoid as much as possible the disputes leading to arbitration, and which will allow him to win the decision when arbitration is necessary. Before coming to his present position in 1946 as Director of the Division of Industrial Relations, Graduate School of Business, Stanford University, he was professor at Duke University and Dartmouth College. He has also been an executive in business organizations, an official in a trade union, and an arbitrator under several collective bargaining agreements.

ROCHESTER CHAPTER

The problem of increasing the number of qualified engineers and scientists so necessary in our modern economy is being met in the Rochester area by an intensive program designed to orient local high school and college students towards careers in engineering and science. The Rochester Chapter of AIIE recently cooperated with other organizations of the Rochester Council of Scientific Societies in an engineering presentation which was most successful in furthering these aims.

The main objective of this particular program was to remove the idea of hopeless complexity from engineering so that the youth of today can better evaluate the profession in terms of their own ambitions and desires in the society of tomorrow.

The program commenced with a short talk on the purpose of engineering, which is: to produce something useful for the consumer, be it goods or services, at a time and price which he determines. The theme of the program, automation, was then discussed, this time to be stripped of its awesome implication by demonstrating the simple principles which are knit into ingenious combinations.

After showing an ASME movie, *To Enrich Mankind*, the visitors were separated into small groups to tour the exhibits. Engineers, acting as guides and demonstrators, displayed eight exhibits, each representing a basic field of science: Heat, Light, Sound, Electricity and Magnetism, Hydraulics, Mechanical Advantage, Time, and Chemical Combination. In turn, each exhibit was subdivided into three phases which consisted of a simple laboratory example, a more detailed, but familiar, application and a highly complex application. A ninth and final exhibit demonstrated that by combining basic and relatively simple mechanisms, automaticity is attained. An automatic washing machine was chosen for a familiar application while zerography and multilith reproduction processes were shown as a more complex illustration.

Questions and comments received more than demonstrated the need of such a program. As a final measure of the success of the presentation, another movie was shown on request before visitors were asked to "please go home".

We in Rochester feel that more work of this nature is urgently needed throughout the country. We urge you to undertake a similar program now so we can help provide engineers for the future. If any additional information is required, please contact our chapter president, Harry L. Davis.

ST. LOUIS CHAPTER

A dinner meeting was held on November 9th. The program consisted of a talk by A. B. Segur, Consulting Engineer, Oak Park, Illinois.

The subject presented dealt with the Motion Time Analysis Predetermined Time System. The speaker emphasized the importance of method in work measurement. A thorough study of motion pattern and method was stated to have far more influence on the results obtained from job study than any other factor. It was held that there is very little difference in the time taken by skilled workers to perform a task, provided motion pattern and methods are identical. Leveling factors were held to be of secondary importance. All present were warned to be continually improving job methods or eventually lose out to competitors who are cognizant of better ways of doing the job.

On January 11, 1956, Mr. R. W. Lindsay, Methods Engineer, American Enka Corporation, Enka, North Carolina, spoke at a meeting of the St. Louis Chapter held at the Town Hall. Mr. Lindsay's subject was Work Measurement of Maintenance Work.

The measurement and control of indirect labor such as maintenance and other similar operations for cost reduction is probably the most fertile field awaiting the application of Industrial Engineering techniques. In most cases, this field has been left untouched.

Mr. Lindsay is a well known speaker, capable of presenting his subject in an understandable and interesting manner. He is in charge of Methods Engineering throughout his company and has done extensive work in the successful analysis, development and application of Work Measurement techniques to maintenance work.

SYRACUSE CHAPTER

The third meeting of the 1955-56 season of the Syracuse Chapter of AIIE took place on Tuesday, November 1. No business was conducted but several announcements were made by Mr. O. Manse as Chapter President and Chairman of our Executive Committee.

This meeting was attended by 68 persons, about half of whom attended the dinner. So far our local membership drive is showing excellent results.

Our speaker was Mr. Conrad Cooper, formerly Vice President of Industrial Engineering, U. S. Steel Corp., now Management Policy Coordinator for USSC. His subject for our meeting, Selling Industrial Engineering, was very interesting and provocative of many questions and requests for comments in the discussion period which followed his talk. Mr. Cooper also discussed specifically USSC management policy with respect to Industrial Engineering.

CONRAD COOPER ADDRESSES SYRACUSE CHAPTER

Left to right: Mr. O. M. Edwards, Syracuse Industrialist; Mr. Tom Flanigan, Chairman of the Membership Committee, Syracuse Chapter; Mr. Otto Manse, President, Syracuse Chapter; Mr. Conrad Cooper, Management Policy Coordinator for U. S. Steel Corp.; Mr. John Carolla, Vice-President, Syracuse Chapter; Mr. Raymond Schneid, Works Manager, Sanderson-Halcomb Works, Crucible Steel Company of America.

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(AIIE Long Range Planning Committee, Industrial Engineering Seminar, Cornell University, October 20–21, 1955)